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# Characteristics of disease patterns in tuna fishermen in Pelita Jaya hamlet, West Seram regency in 2024

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## ABSTRACT

***Background:*** *Indonesia is the largest archipelagic country in the world with diverse marine and fisheries potential. Indonesia has a 16% role in supplying the world's tuna fish needs. However, the life of a tuna fisherman is far from healthy. This is caused by a lack of awareness about maintaining health. This research aimed to determine the characteristics of disease patterns in tuna fishermen in Pelita Jaya Hamlet, West Seram Regency in 2024.*

***Material and methods:*** *The number of samples in this study consisted of 68 people. The sampling technique in this study was accidental sampling. The subjects in this study were tuna fishermen ≥ 18 years old who were willing to become respondents. The research was conducted at Pelita Jaya Hamlet Fish Port, West Seram Regency in May 2024. The method used in this research is mixed quantitative using questionnaires and qualitative with Focus Group Discussion (FGD).*

***Results:*** *The results of this research are the characteristics of tuna fishermen in Pelita Jaya Hamlet, West Seram Regency are dominated by tuna fishermen aged 36–45 years, education level is dominated by high school/MA graduates, work period is dominated by 16–20 years, smoking status is dominated by moderate smokers, and Alcohol consumption is dominated by the moderate category. The most common disease patterns among tuna fishermen in Pelita Jaya Hamlet are based on noninfective diseases dominated by gastritis, infective diseases dominated by Acute Respiratory Infection (ARI), and occupational diseases dominated by lower back pain (LBP).*

***Conclusions:*** *Tuna fishermen are in poor condition. Almost all fishermen have > 1 disease. The most characteristic disease pattern based on non-communicable diseases is gastritis with 30 respondents (44.1%), based on infectious diseases is ARI with 51 respondents (75.0%) and based on occupational diseases is LBP with 51 respondents (75.0%).*

*(Int Marit Health 2025; 76, 2: 87–92)*

**Keywords: disease patterns, fisherman, health, tuna fishermen**

## INTRODUCTION

Indonesia is the largest archipelago in the world with the diversity of Indonesian marine products which is one of the most complete in the world. As a maritime country, Indonesia has enormous and diverse marine and fisheries potential. Based on data from the Central Bureau of Statistics in 2023, the value of capture fisheries production in Indonesian seas according to the main commodities, dominated by tuna. The marine and fisheries sector is one of the sectors that has a role in economic development

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and health, especially in providing fish as a protein ingredient, earning foreign exchange, and providing employment [1, 2].

Based on data from the Food and Agriculture Organization (FAO) in 2020, Indonesia accounted for 16% of the world's tuna supply. As a maritime country with enormous marine potential, Indonesia is the largest tuna producer and has a significant opportunity to dominate the global tuna market. In addition, Indonesia has been a member of the Indian Ocean Tuna Commission (IOTC) since 2007 [3].

Tuna is one of the leading commodities in the industrialization program because it is a fish with high economic value and plays an important role as a foreign exchange earner. Demand for tuna is also increasing along with changes in global consumer preferences from red meat to white meat [4].

One of the provinces in Indonesia that has a large coastal area. Maluku Province is an archipelago with an area of 712 479.65 km$^2$ consisting of 92.4% water area and 6.5% land area. Therefore, the fisheries sector in Maluku plays an important role as the main livelihood. The people of Maluku utilize this fishery wealth by working as fishermen. According to data from the Central Bureau of Statistics in 2018, economic activities in Maluku are dominated by the fisheries sector. Based on production data and production value of capture fisheries at sea by district/city and main commodities in Maluku Province in 2022, West Seram Regency is the largest tuna producer with a production of 25 586 tons [5, 6].

Every job has risks that must be faced, including working as a tuna fisherman. Health problems faced by fishermen can cause various diseases. Research by Fitri Sari Dewi et al. in 2023 revealed that occupational diseases of fishermen that can occur back and waist pain, stinging or blisters due to fish spines, fatigue, eye disorders or myopia, allergies or itching, sprains, fractures, and other common diseases, including fever, flu, headaches, colds, rheumatism, and boils. In addition, research by Dillyana Vinezzia et al. in 2021 revealed that various potential hazards can be experienced by fishermen. Examples of ergonomic potential hazards such as low back pain. Environmental potential hazards such as injury. Psychosocial potential hazards can arise from various aspects, such as uncertain natural conditions such as stress and anxiety [7, 8, 9].

## MATERIAL AND METHODS

The number of samples in this study consisted of 68 people. The sampling technique in this study was accidental sampling. The subjects in this study were tuna fishermen ≥ 18 years old who were willing to become respondents. The research was conducted at Pelita Jaya Hamlet Fish Port, West Seram Regency in May 2024. The method used in this research is mixed quantitative using questionnaires and qualitative with Focus Group Discussion (FGD).

### METHOD DESCRIPTION

The sampling technique used was accidental sampling. Respondents are selected based on their presence in a location relevant to the research context. This study employs both quantitative and qualitative methods to obtain comprehensive data and insights. The quantitative research method was carried out through a survey using a questionnaire. The qualitative method used was the focus group discussion (FGD) method. The questionnaire contained questions covering personal data (name, age, education level, tenure, smoking habits, and alcohol consumption) and disease patterns in fishermen. The list of questions in the FGD included daily routines, health problems, work challenges, daily diet, smoking habits, alcohol consumption, and the use of personal protective equipment in tuna fishers.

## RESULTS

Based on the results of the study in Table 1 with 68 respondents, it was found that the characteristics of most respondents were in the age range of 36–45 years, 23 respondents (33.8). Characteristics of respondents based on the highest level of education, namely at the SMA/MA level with 30 respondents (40.1). Based on the respondent's working period, it was found that the most respondent data were respondents who worked 16–20 years (27.9). Based on the respondent's smoking status (per day), it was found that most respondent data were moderate smokers (11–24 cigarettes) as many as 31 respondents (45.6). Based on the respondent's alcohol consumption, it was found that most respondents consumed alcohol (per day) with a moderate amount (201–300 ml) as many as 23 respondents (33.8).

Based on Table 2, the data on the number of disease occurrences in tuna fishermen is very high. This happens because many tuna fishermen have> 1 disease. In noninfectious diseases, the most common disease pattern was gastritis with 30 respondents (44.1) and the least was cataract disease pattern and Diabetes Mellitus (DM) with 3 respondents (4.4). In infectious diseases, the most common disease pattern was acute respiratory infection with 51 respondents (75.0). In occupational diseases, the most common disease pattern was Lower Back Pain (LBP) with 51 respondents (75.0), and the least common disease pattern was contact dermatitis with 25 respondents (36.0).

## DISCUSSION

Disease patterns in tuna fishermen based on noninfectious diseases, gastritis has the highest number followed

**Table 1.** Distribution of tuna fishers in Pelita Jaya Hamlet

| Respondent characteristics | n | % |
|---|---|---|
| **Age (years)** | | |
| 18–35 years old | 12 | 17.6 |
| 36–55 years old | 45 | 66.2 |
| > 55 years old | 11 | 16.2 |
| **Total** | **68** | **100.0** |
| **Education level** | | |
| Ungraduated elementary school | 6 | 8.8 |
| Elementary school | 8 | 11.8 |
| Junior high school | 23 | 33.8 |
| Senior high school | 31 | 45.6 |
| **Total** | **68** | **100.0** |
| **Period of employment** | | |
| 6–10 years | 18 | 26.5 |
| 11–20 years | 27 | 39.7 |
| ≥ 21 years | 23 | 33.8 |
| Total | 68 | 100.0 |
| Smoking status | | |
| No smoking | 8 | 11.8 |
| Smoker | 60 | 88.2 |
| **Total** | **68** | **100.0** |
| **Alcohol consumption** | | |
| No alcohol consumption | 10 | 14.7 |
| Light (100–200 ml) | 9 | 13.2 |
| Medium (201–300 ml) | 23 | 33.8 |
| Heavy (> 300 ml) | 26 | 38.2 |
| **Total** | **68** | **100.0** |

**Table 2.** The most common disease pattern in tuna fishers in Pelita Jaya Hamlet

| Disease pattern characteristics | n | |
|---|---|---|
| **Noninfectious diseases** | | |
| Gastritis | 30 | 44.1 |
| Hypertension | 7 | 10.2 |
| Diabetes mellitus | 4 | 5.8 |
| Pterygium | 3 | 4.4 |
| Cataract | 3 | 4.4 |
| **Infectious Disease** | | |
| ARI | 51 | 75.0 |
| Diarrhea | 36 | 52.9 |
| Malaria | 9 | 13.2 |
| Dengue fever | 1 | 1.4 |
| Filariasis | 1 | 1.4 |
| **Occupational Diseases** | | |
| LBP | 51 | 75.0 |
| Vulnus | 49 | 72.0 |
| Myalgia | 48 | 70.5 |
| Contact dermatitis | 25 | 36.0 |

ARI — acute respiratory infection; LBP — lower back pain

by hypertension, pterygium, diabetes mellitus, and cataracts. The incidence of gastritis in tuna fishermen can be caused by their irregular diet. According to the FGD results, they have an irregular diet because of their erratic work, and they will eat after finishing work. Meanwhile, when the number of fish obtained is large, they will work longer. Research by Borah et al. [10] in 2023 stated that the incidence of gastritis can be caused by stress and anxiety. In addition, eating habits, drug consumption, and lack of knowledge about gastritis can be risk factors. This is in line with the research of Suwindri et al. [11] in 2021 who stated that gastritis can be caused by an irregular eating schedule which will certainly attack the stomach and risk causing gastritis, prolonged stress resulting in increased gastric acid production, alcohol consumption can stimulate gastric acid production and damage the gastric mucosa, and smoking habits increase gastric acid secretion which results in smokers suffering from gastritis to gastric ulcers.

The incidence of hypertension is often not recognized because it is asymptomatic, but it is still dangerous because it can lead to various complications. Based on. Tuna fishers have a habit of eating fish while working. In accordance with the results of the FGD, they said that they eat fish every day and consume coffee/tea in the morning which can be a risk factor for hypertension. Research conducted by Rumaolat et al. [12] in 2023 stated that the incidence of hypertension

can be influenced by several factors, namely age, gender, obesity from drugs, and the use of steroid drugs. In addition, fishermen have jobs that require physical endurance so many fishermen consume caffeine to help their performance while working. This habit can be a factor that can cause hypertension in tuna fishermen.

In the incidence of diabetes mellitus, a fisherman has the potential to experience diabetes mellitus because of old age and a poor diet. Tuna fishermen in Pelita Jaya Hamlet are dominated by old age. This is due to the work of tuna fishermen who require high experience and knowledge about their work. Based on the results of FGD, tuna fishermen have a habit of consuming coffee and tea and eating rice which is a meal that contains carbohydrates and has a sugar content that can cause Diabetes Mellitus. Based on research conducted by Fadzilah et al. [13] in 2020, the factors associated with diabetes are older age, larger waist circumference, and poor diet.

Pterygium is a degenerative and invasive condition that is generally bilateral on the nasal side of the eye. It is usually triangular, with the head or apex facing towards the center of the cornea and the base facing the semilunar fold of the cantus. Pterygium is more common in individuals who are often exposed to high-intensity sunlight, especially those with outdoor activities such as fishermen [14]. In theory, pterygium can occur in tuna fishermen because they are always exposed to sunlight, wind, and hot air while working. In addition, they work in the middle of the sea without using personal protective equipment such as hats, jackets, and glasses to protect them from sun exposure even though sunlight is the cause of pterygium. Based on research conducted by Wati et al. [15] in 2023, exposure to ultraviolet light (UV) and hot, dry, and dusty air can be a risk factor for suffering from pterygium and cataracts.

Disease patterns in fishermen based on infectious diseases, acute respiratory infection ranks first followed by diarrhea, malaria, dengue fever, and filariasis. Acute respiratory infection cases do not only affect children. When viewed from the source of the cause, everyone could contract acute respiratory infection including a fisherman, if exposed to the source of the cause. Even though the weather is rainy, hot, or cloudy, they will still go to sea. This is due to the demands of being the head of a family who earns a living. This is exacerbated by the habit of using personal protective equipment that is lacking, making them vulnerable to acute respiratory infections.

The incidence of diarrhea is often caused by the unhygienic lifestyle of a fisherman. Based on the FGD results, tuna fishers have a lack of clean-living behaviors, rarely wash their hands, and have limited access to clean water which can cause them to be contaminated with microorganisms/pathogens that cause diarrhea. Based on research conducted by Harahap et al. [16] in 2020, the behavior of not washing hands after carrying out activities related to the environment can have a negative impact on health, especially the emergence of diseases related to low clean and healthy living behavior such as diarrhea.

In malaria incidence, there are many related factors such as environmental changes that will result in the expansion of the breeding environment for malaria-transmitting mosquitoes, high population mobility, and climate change which has become de facto a longer rainy season and intermittent dry season. Changes in sunlight and climate will affect the biology, distribution, and population density of vectors at certain times and places. Research conducted by Suwarja et al. [17] in 2012 stated that jobs that are oriented outside the home and work at night are fishermen. Fishermen work around the beach or sea which allows contact with disease-causing vectors (anopheles mosquitoes) when working or unloading sea products at dusk and early morning.

The disease pattern based on occupational diseases is LBP followed by vulnus/injury, myalgia, and contact dermatitis. Tuna fishermen can experience LBP because their work requires physical and muscle strength. Meanwhile, a person's physical and muscle strength can decrease with old age. Based on research by Subarjo PM et al. [18] in 2021, work-related musculoskeletal complaints in fishermen will increase with age, due to decreased bone density. The older the age, the longer the working period, and the riskier the work attitude, the more likely the respondent will experience complaints of low back pain/LBP.

In the incidence of vulnus/injury, this is because when fishing, the average fisherman does not use personal protective equipment such as gloves when pulling the fishing rod. Non-compliance with the use of protective equipment in fishermen causes many fishermen to experience vulnus/injury complaints. This is in line with the results of research by Zurimi et al. [19] in 2019 which stated that the incidence of lacerations or vulnus laceratum can occur in fishermen who are not compliant with using Personal Protective Equipment (PPE) in full on their body parts so that if direct contact occurs, vulnerable body parts are not protected and increase the risk of lacerations or vulnus laceratum.

In the incidence of myalgia, work activities as a fisherman include force/load, poor work posture, repetition, and long work duration. In addition, improper work postures can cause persistent static loads on certain soft tissues, potentially causing disruption and deterioration of muscles, bones, and joints. This leads to complaints of muscle pain, based on research by Sumardiyono et al. [20] in 2017 who stated that the risk of muscle pain complaints is found in various industrial sectors in Indonesia due to non-optimal work attitudes.

In the incidence of contact dermatitis, this complaint can be experienced by fishermen because they are not used to contact with seawater and an unclean work environment. Research by Cahya et al. [21] in 2012 stated that fishermen are prone to skin diseases because they are often exposed to seawater which contains many bacteria. Skin contact with seawater can make it wet and then dry due to salt concentration, which can cause the skin to feel itchy and scaly. Seawater is the main cause of irritant dermatitis in fishermen. While working as tuna fishermen, being exposed to fish blood and seawater splashes has become a daily routine, and they even use seawater for bathing while on the boat.

## CONCLUSIONS

Tuna fishermen are in poor condition. Almost all fishermen have > 1 disease. The most characteristic disease pattern based on non-communicable diseases is gastritis with 30 respondents (44.1), based on infectious diseases is ARI with 51 respondents (75.0) and based on occupational diseases is LBP with 51 respondents (75.0).

## ARTICLE INFORMATION AND DECLARATIONS

**Data availability statement:** The authors confirm that the data supporting the findings of this study are available within the article.

**Ethics statement:** Ethical permission to conduct health research entitled "Characteristics of Disease Patterns in Tuna Fishermen in Pelita Jaya Hamlet, West Seram Regency in 2024" has been obtained from the Faculty of Medicine, Pattimura University (Certificate of Ethical Permission to Conduct Medical Research at the Faculty of Medicine, Pattimura University). Medical Research at the Faculty of Medicine, Pattimura University, Ref. No. 047/FK-KOM. ETIK/VIII/2024).

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**Supplementary material:** The supplementary material, including data analysis, pictures, videos, and respondent information, is available upon reasonable request from the corresponding author.

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CASE REPORT

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# A smartwatch electrocardiogram for atrial fibrillation detection: a case report

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## ABSTRACT

*Early detection and accurate diagnosis are crucial for effective management and prevention of complications associated with atrial fibrillation (AF). The advent of wearable technology has revolutionized the way we detect and monitor cardiac conditions. This case report describes a patient who requested medical assistance from the Centro Internazionale Radio Medico (CIRM), the Italian Telemedical Maritime Assistance Service (TMAS) center and was diagnosed with AF while on board a merchant ship using a smartwatch Electrocardiogram (ECG).*

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**Keywords: heart diseases, atrial fibrillation, cardiovascular diseases, heart attack**

## INTRODUCTION

Among seafarers, acute cardiac events are particularly concerning as they contribute to medical consultations, disembarkations, repatriations, and unfortunately, mortality at sea [1–5]. Atrial fibrillation (AF) is one of the prevalent heart diseases among seafarers on board ships. However, the unique nature of their work poses significant challenges in detecting and managing AF at sea. One of the primary challenges faced by seafarers in the detection and management of atrial fibrillation is the limited access to medical resources at sea. The remote locations of ships, especially during long voyages, further contribute to the challenges faced by seafarers in detecting and managing atrial fibrillation. To overcome this obstacle, new technologies have emerged to assist in the early detection of AF. One such technology is smartwatch ECG applications, which allow users to record electrocardiograms during symptomatic episodes. This case highlights that merchant ships should be equipped with technologies measuring heart electrical activity.

## CASE REPORT

A 43-year-old chief officer, a United Kingdom (UK) seafarer, experienced a sudden illness accompanied by chest pain while working on a merchant ship in the middle of the Indian Ocean. In addition, the seafarer's awakening was met with a sense of discomfort, as a wave of malaise washed over him. Alongside this unease, an unpleasant sensation of palpitation gripped his chest, causing him great concern. The weight that seemed to rest in the center of his chest added to his distress, occasionally becoming sharp on the left side, just beneath his ribs. CIRM received a request for medical assistance on September 29th, 2023, on World Heart Day. Despite his blood pressure being within acceptable limits (the first blood pressure measurement reported a value of 115/80 mmHg, and after about two hours, a second blood pressure measurement was 110/70 mmHg), it was noted that he also exhibited tachycardia, along with an irregular heartbeat. These symptoms suggested the presence of atrial fibrillation, a common heart rhythm disorder. Unfortunately, the ship did not have an electrocardiograph,

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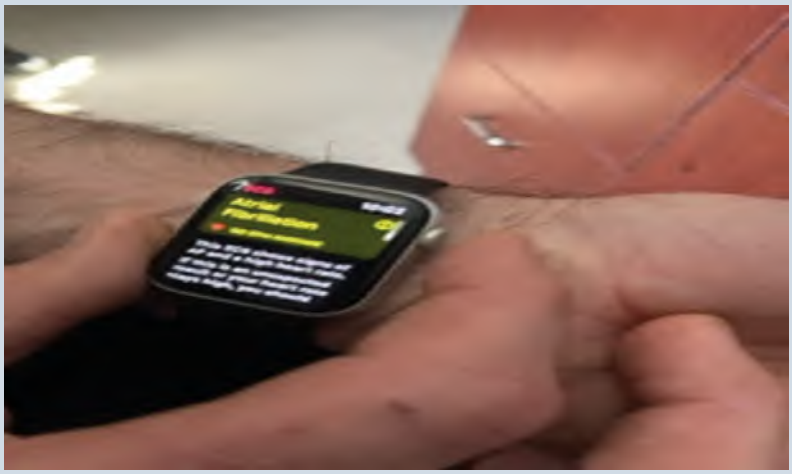

**Figure 1.** Smartwatch ECG performed on the patient onboard ship

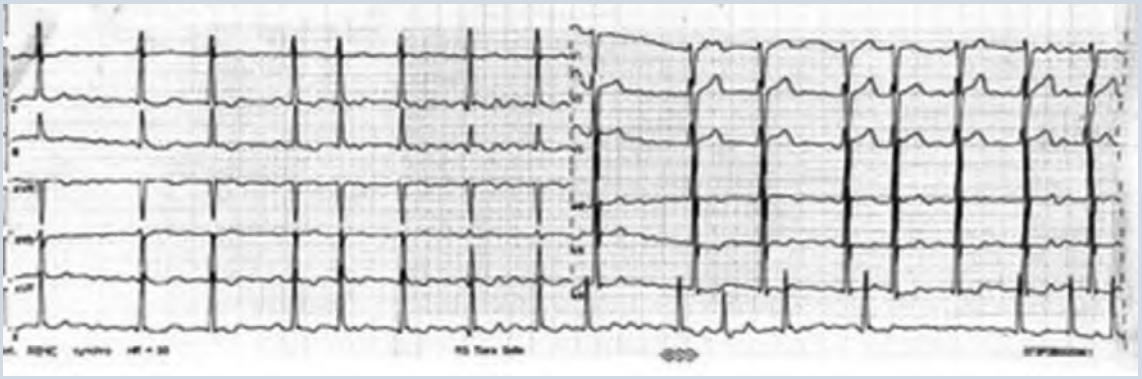

**Figure 2.** The electrocardiogram (ECG) was performed on the patient at the hospital

which would have been instrumental in confirming the diagnosis and guiding the appropriate treatment. Complicating matters further, the ship was too far away from the mainland to activate rescue services promptly. In this critical situation, the captain's promptness and the doctor on duty at the CIRM competence proved to be a fortunate combination. In a critical situation in the middle of the Indian Ocean, where immediate medical attention was required, a captain and doctor on duty used their heads to save the sailor's heart. With limited resources available, they turned to a smartwatch and its ECG application to assess the condition of a crew member's heart. Both the captain and doctor on duty, knowing the importance of time in such a situation, quickly utilized the ECG application on a watch. Within seconds, the application confirmed the diagnostic hypothesis, allowing the doctor on duty to identify the specific issue affecting the crew member's heart (Fig. 1).

The doctor on duty reviewed the ECG recording and recommended that the vessel be diverted to the nearest port for appropriate medical treatment and additional diagnostic tests. Upon the doctor's recommendation, the captain diverted the ship to the nearest port where the crew member could receive medical treatment. Following the initial diagnosis, as the first treatment metoprolol 100 mg one tablet a day + aspirin 300 mg one tablet a day was administered onboard. Some days later, a cardiological report was received from the hospital where the sailor had been admitted and atrial fibrillation had been confirmed at the hospital (Fig. 2).

The seafarer was repatriated safely with the appropriate treatment. As for his past medical conditions, apparently with no past medical history and no known medical conditions that may have contributed to the AF event. The patient did not present any complications associated with the AF

event and he was diagnosed with "new-onset AF." In this story, a request for medical assistance for a cardiac problem was successful in reaching a happy conclusion on World Heart Day. In the realm of cardiovascular prevention, there is a pressing need for innovative solutions that can reach remote areas and ensure timely access to specialized medical care. By leveraging current technology, we can bridge the gap between isolated regions and the expertise of highly qualified medical specialists, thereby initiating a paradigm shift in healthcare provision at sea. Merchant ships play a crucial role in global trade and commerce, transporting goods across vast oceans. However, the safety and well-being of the crew members onboard these vessels are of paramount importance. Are merchant ships truly considered a "safe and cardio-protected workplace" in today's world? The provision of an electrocardiograph and a defibrillator on board merchant ships is not a technological revolution but rather a necessary act of civility.

## DISCUSSION

This study reports a unique case of a patient who was diagnosed with AF using a smartwatch ECG in the middle of the ocean through telemedicine. To the best of our knowledge, this is the first reported instance of such a diagnosis carried out under these circumstances. The patient's diagnosis was later confirmed at the hospital. The doctor on duty at the CIRM assessed the smartwatch ECG data and identified irregularities consistent with atrial fibrillation. Recognizing the urgency of the situation, the doctor advised the patient to seek immediate medical attention at the nearest port. This case highlights the potential of telemedicine and of a smartwatch ECG in facilitating timely diagnosis and management of cardiovascular conditions, even in remote locations, especially at sea. The ability to receive medical advice and guidance from the TMAS center while in the middle of the ocean has the potential to save lives and improve patient outcomes. Studies conducted among the general population have identified high blood pressure, advanced age, high body mass index (BMI), diabetes, sleeping apnea, coronary heart disease, heart failure, alcohol consumption, smoking, and long working hours as common risk factors for AF [6–8]. These risk factors, especially high blood pressure, smoking, and high body mass index were more prevalent in seafarers compared to ashore workers [9–11]. As the studies have shown, seafarers exhibit a higher prevalence of risk factors associated with AF when compared to the general population.

The physically demanding and stressful nature of their work, coupled with unhealthy lifestyle choices, contribute to this elevated risk. Recognizing these risk factors and implementing appropriate preventive measures are crucial in reducing the incidence of atrial fibrillation among seafarers and promoting their overall cardiovascular health. The feature fortunately available on board offered a convenient and accessible method for seafarers to monitor their cardiac rhythm. In this case, the patient's recordings provided valuable insights into the nature and frequency of his AF episodes. The ability to capture real-time ECG data during symptomatic periods was particularly advantageous in confirming the diagnosis of AF. The Watch ECG feature has shown promise in facilitating the detection and timely intervention of seafarers with suspected AF.

## CONCLUSION

This case highlights the need for cardiac diagnostics such as electrocardiograms and defibrillators on board seagoing vessels and the potential of telemedicine using wearable technology to provide prompt diagnosis in case of cardiovascular emergencies on board ships.

## CONSENT

Written informed consent was obtained from the patient for publication of this case report.

## ARTICLE INFORMATION AND DECLARATIONS

**Ethics statement:** Written informed consent was obtained from the patient for publication of this case report.

**Author contributions:** C.R. — conceived and designed the study, interpreted the data and results, and drafted the initial case report; F.A. — reviewed, guided, and approved the study; U.A., E.M.F., F.V. — contributed to data collection and drafted the case report; G.G.S. — conceived and designed the study, interpreted the data and results, and drafted the initial case report. The final version of the case report has been read and approved by all authors.

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**Conflict of interest:** The authors declare no conflicts of interest.

**Supplementary material:** Not applicable.

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# Medical causes of repatriation in commercial seafarers and offshore workers: a scoping review

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## ABSTRACT

***Background:*** *Workers at sea including commercial seafarers and those working in offshore establishments have increased risk for occupational disease and injury. Due to limited medical resources in vessels and platforms, and the remote nature of the work, repatriation to a shore-based facility may be required for treatment. The objective of this review was to summarize the literature on medical causes of repatriation among commercial seafarers and offshore workers.*

***Materials and methods:*** *As per Joanna Briggs Institute (JBI) methodology for scoping reviews, a search for papers in English of Medline, Embase, Cumulative Index to Nursing and Allied Health Literature (CINAHL), Scopus and Oceanic Abstracts was conducted. Studies that reported medical causes of repatriations in commercial seafarers and offshore workers were included. For the purposes of this study, commercial seafarers and offshore workers are defined as persons working in the maritime environment for three or more consecutives days. Recreational seafarers, passengers, and military personnel were excluded. Included papers underwent data extraction and medical causes of repatriation were classified into International Classification of Disease (ICD) 11$^{th}$ Revision codes.*

***Results:*** *The search yielded 33 publications including 27 retrospective studies and 6 case studies. 9 of 27 studies focused on offshore workers and 18 included seafarers. The most common causes of medical repatriation reported in the literature were injuries, poisonings, and other consequences of external causes (ICD-22, ICD-23) at 25.2%. Diseases of the digestive system, including dental, (ICD-13) comprised 15.9%, and the musculoskeletal system (ICD-15) was 13.3%.*

***Conclusions:*** *Gaps in the available literature included a lack of demographic and occupational information required to properly assess risk factors for occupational illnesses and injuries among seafarers. The data indicate that injuries, diseases of the gastrointestinal system, and musculoskeletal system are the most common literature-reported causes of repatriation in occupational seafarers. This work may support enhancements to onboard medical capability and medical standards for workers in the marine and offshore industries.*

*(Int Marit Health 2025; 76, 2: 97–114)*

**Keywords: marine medicine, occupational medicine, seafarers, offshore, medical evacuation**

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## INTRODUCTION

Each day occupational illnesses and injuries are experienced on board commercial ships and offshore platforms at sea. There are nearly 1.9 million seafarers working on the high seas to enable over 80% of global trade [1]. Due to the remote and specialized nature of the work, limited resources, and distance to shore, challenging decisions must be made regarding how to best manage occupational injuries and illnesses when they arise while also balancing operational considerations. Diagnostic uncertainty and/or insufficient medical management can cause chronic complications or even death in seafarers while waiting until the next port of call (NPOC) for treatment. The lack of diagnostic clarity may also lead to large and unnecessary costs for the vessels, delays in cargo delivery, and additional risk when transporting patients for advanced medical care [2]. Medical repatriation is generally the final and most costly course of action for a serious injury or illness incurred at sea. This scoping review aims to explore the published literature pertaining to medical causes of repatriation in those who work in the commercial seafaring and offshore industries.

It has been well documented that seafarers who work in a maritime environment experience an increased risk of illness and injury relative to the general population [3]. The severity of the injury or illness can vary greatly, and the impact can range from inability to perform daily tasks up to a requirement for repatriation (delivery of the affected person to a port for medical intervention). In order to advance our understanding of seafaring and offshore operational medical requirements as well as a with a lens toward prevention, a deeper understanding of the repatriation literature is needed. Several studies have been conducted that analyse the causes of repatriations, but these studies have been confined to a geographical location or a specific database. It has been noted that the some of the literature tends to focus on a singular facet of the problem, such as telemedicine usage, which is less likely to address the overarching trends and specific characteristics of medical repatriations [4]. Carter indicated in 2011 [4] that there was limited published data related to medical repatriations in the maritime environment. Since that publication, there have been several studies reported which have helped to further the goal of improving occupational healthcare and screening criteria for those working at sea and offshore.

This literature study aims to serve the working population known as seafarers or sailors. The Maritime Labour Convention of 2006 defines seafarer as "any person who is employed or engaged or works in any capacity on board a ship" [5]. Additionally, the same convention mandates increased medical capabilities on vessels that spend three or more consecutive days at sea [5]. Using these two criteria to establish the population for this study meets the aim of assessing the impacts on the commercial seafaring and offshore industries and allows for the exclusion of passengers on transport, recreational, and military vessels. Offshore workers have also been included due to similarities in the remote nature of the work and onboard medical capabilities, although they are not specifically legislated under the Maritime Labour Convention.

A paper on the knowledge base for maritime health indicated that increased attention to the study of injury and illness at sea could lead to improvements in medical pre-screening, crew medical training, medical facilities on board, as well as better telemedicine and repatriation arrangements [4]. Therefore, by synthesizing all the available published data herein, this study aims to guide further research on the topics of occupational screening, illness and injury prevention, and crew medical training as applied to the global seafaring and offshore working populations. By categorizing the data into the International Classification of Diseases 11$^{th}$ Revision (ICD-11), we aimed to provide a data set that can be interpreted and applied across various industries in any geographical location and guide future research.

Due to the heterogeneous nature of the literature that will be examined, a scoping review methodology was selected. There is no clear body of literature that would support a systematic review. A preliminary search of Medline and Embase was conducted and no current or underway systematic or scoping reviews on the topic were identified.

## MATERIALS AND METHODS

### OBJECTIVE & REVIEW QUESTION

The objective of this review was to summarize the literature on medical causes of repatriation among commercial seafarers and offshore workers. It was guided by the following specific review question: what are the causes of medical repatriations in commercial seafarers and offshore workers?

### INCLUSION CRITERIA

#### Participants

The participants for this study are defined as anyone who works in a maritime environment, including vessels and offshore platforms, for a duration of three consecutive days or longer, as per increased medical requirements in the Maritime Labour Convention [5]. The age range for this review will was 18–65 years old to represent the general workforce of interest. Passengers on transport vessels and recreational seafarers were excluded from this review. Military populations were also excluded due to the unique nature of their work. There will be no limitation on the size of the study included in this review.

### Concept

The concept being investigated in this review is the cause of medical repatriations within the participant population. The causes will be classified as injury or illness and further grouped by type of disease in accordance with ICD-11. Any study that investigates medical repatriations in a maritime environment will be included. Studies that detail deaths at sea where repatriation did not occur will not be included.

### Context

The context of this study is to explore the published literature evidence related to medical causes of repatriation in the maritime work environment. Seafaring and offshore workers experience specific occupational risks and this study aimed to identify trends in the literature with the goal of identifying targets for possible improvements in the management of illness and injury at sea.

## SEARCH STRATEGY AND REVIEW METHODOLOGY

This scoping review was conducted in accordance with the JBI methodology for scoping reviews [6]. The protocol for this scoping review was registered in the *Open Science Framework Registries* [7]. The text words contained in the titles and abstracts of relevant articles, and the index terms used to describe the articles were used to develop a full search strategy for Embase, Medline, CINAHL, Oceanic Abstracts, and Scopus databases. The search strategy, included all identified keywords and index terms, and was adapted for each database and/or information source. All included studies then underwent citation screening. The grey literature search included the International Maritime Organization (IMO), United States Coast Guard (USCG), and Canadian Coast Guard (CCG) websites for any publications that meet the inclusion criteria of this study. Only studies that are published in English were included. The final search strategy is included in *Supplementary material* (Appendix 1).

All identified sources were uploaded to Covidence (Veritas Health Innovation, Melbourne, Australia) for screening. Titles and abstracts, and subsequently the selected full texts, were screened for inclusion by both authors independently. Any disagreements were resolved through detailed analysis of the article against the inclusion criteria. The results of the search process are reported via a Preferred Reporting Items for Systematic Reviews and Meta-analyses extension for scoping review (PRISMA-ScR) flow diagram (Fig. 1). Data from the included resources was extracted by the two authors. Where studies did not identify ICD codes in reporting their data, the authors classified medical causes and diagnoses into ICD categories. The authors have indicated the studies where medical causes of repatriation were classified into ICD categories. The original raw data extracted from included papers is available upon request or the reader is directed to individual papers listed in Table 1.

# RESULTS

## SEARCH RESULTS

A total of 33 papers met our inclusion criteria with 27 retrospective studies. There were 18 studies that focused on seafarers and 9 studies that focused on offshore workers. 6 case studies were also included for completeness. Appendix 1 details the search strategy and Figure 1 details the screening and review process. All but one of the studies were obtained through the initial search and the final study was added through a citation search within the included papers. The publication dates of the studies range from 1981 to 2023.

## PUBLISHED STUDIES — CHARACTERISTICS

Table 1 details the characteristics of the included studies. Most studies included are retrospective studies focusing on a specific population or geographic area. The literature represented the global population of seafarers with studies included from the Americas, Europe, Middle East, Asia, and Oceania. There were limited sources of data from Africa and South America. 6 of 33 papers included are case studies focusing on one specific medical event and will be discussed separately. Only 12 of 27 (44%) papers included data on the age of the medical evacuees and even fewer, 6 of 27 (22%), reported on occupation description or rank. Some of the studies included sex of the repatriated population but the workforce being studied is overwhelmingly male. Where female seafarers were included, there was limited or no discussion surrounding sex-based risk factors or trends.

## REPATRIATIONS AND ICD CODES

The studies yielded a total population of 1,042,981 workers and 28,170 medical repatriations. 12 of 27 papers classified disease and injury using the ICD codes and the remainder were classified using other systems that were easily interpreted and converted into ICD classification by the authors for the purpose of tabulation (Table 2). The results indicate that the most common causes of medical repatriation or evacuation are injuries, poisonings, and other consequences of external causes (ICD-22, ICD-23) at 25.2%. This is followed by diseases of the digestive system, including dental, (ICD-13) at 15.9%, and diseases of the musculoskeletal system or connective tissue (ICD-15) at 13.3%. The studies with n > 500 sailors (Abaya 2015, Abaya 2018, Abaya 2023, Bell 2009, Huerte 2023, Norman 1988, Ponsonby 2009) all align with the total data set showing ICD-13, ICD-15, and ICD-22 as the leading causes of repatriation. This data is represented in Table 2 with disease classification as

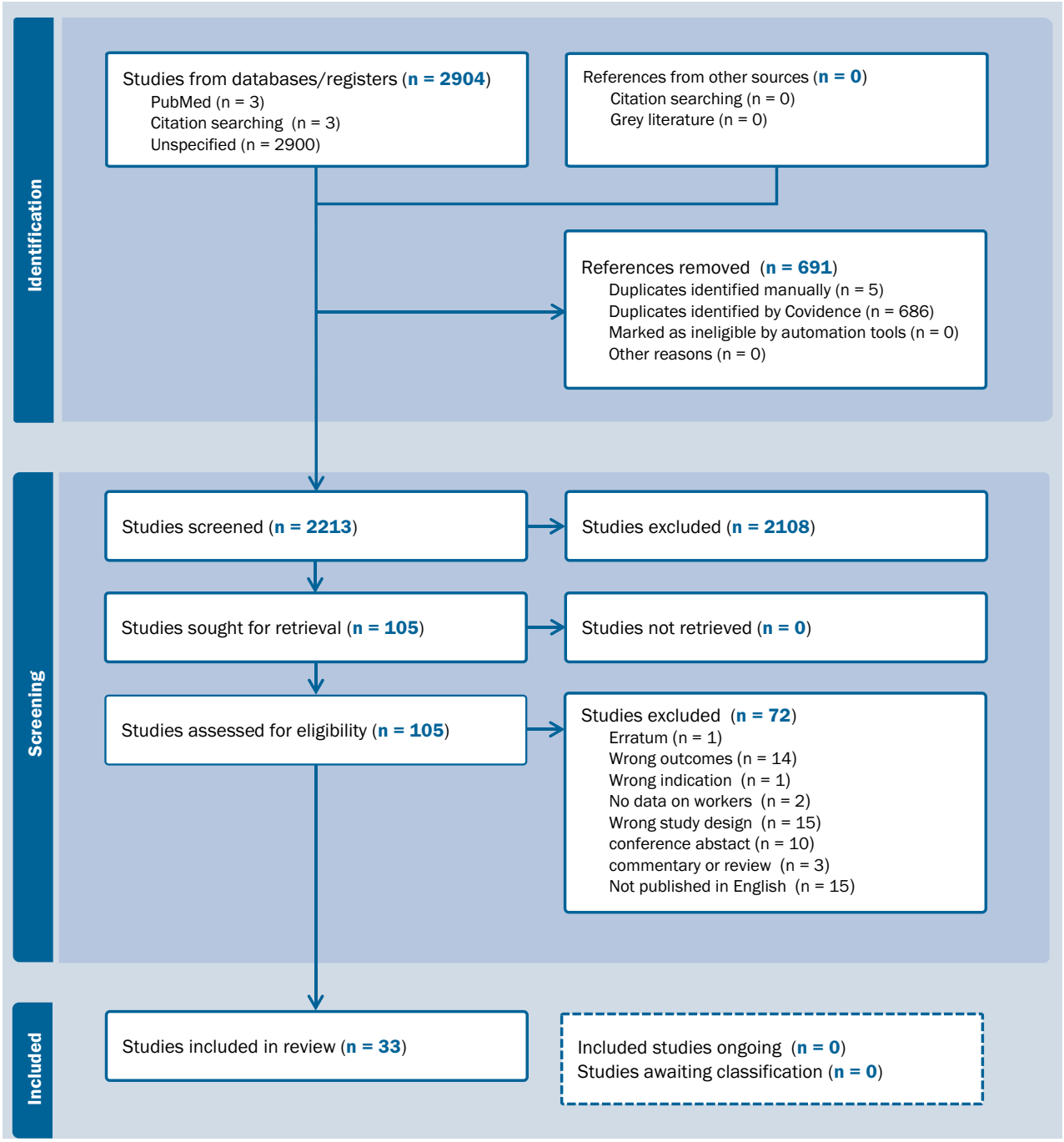


**Figure 1.** Preferred reporting items for systematic reviews and meta-analyses

a percentage of total repatriations. The raw data extracted from included papers is available upon request or the reader is directed to individual papers listed in Table 2.

There were 6 case studies included in this study. The case studies comprehensively describe the case demographics which offer more insight into the specific occupational hazards associated with seafaring. They provide clear examples of how shortcomings in the medical screening process [8] or occupational safety [9] can lead to medical repatriations.

The grey literature review did not yield any studies pertinent to this review.

## DISCUSSION

The aim of this study was to map and collate the literature surrounding medical repatriations at sea and answer the question "What are the medical causes of repatriations among commercial seafarers and offshore workers?". Lucas et al. [10] noted "that for the last forty years, the National

**Table 1.** Characteristics of included studies

| Author and year | Study type & data source | Location | Sample size | Number of repats(n) | Sex (% of n) | Age (% of n) | Rank (% of n) | Occupation by Dept. (% of n) | Relevant results or findings |
|---|---|---|---|---|---|---|---|---|---|
| Abaya (2015) [13] | Retrospective study.<br><br>Collected aggregate data from claims and legal departments of manning agencies.<br><br>Classified using ICD-10 | Philippines | 388,963 | 6579 | NR | NR | NR | NR | Top 5 causes of medical repatriation: injuries (21.4%), musculoskeletal (19.4%), gastrointestinal (17.1%), genitourinary (8.9%) and cardiovascular (8.1%) Top 5 = ~75% of all repatriations. |
| Abaya (2018) [26] | Retrospective study.<br><br>Data taken from records at Health Metric Inc, a diagnostic clinic providing pre-embarkation medical exams to Filipino seafarers.<br><br>Classified using ICD-10 | Philippines | 51,830 | 840 | NR | Similar outcomes across all age groups. | NR | NR | Repatriation rate of 1.6% among cargo ship and passenger ship seafarers who have stayed for more than 200 days at sea, with illnesses as the major cause for both populations (94.5% and 73.9% for cargo and passenger ship seafarers, respectively). |
| Abaya (2023) [12] | Retrospective study.<br>Data sourced from various manning agencies in Metro Manila.<br><br>Classified using ICD-10 | Philippines | 464,418 | 6526 | NR | Mean age: 40.9yrs | NR | Deck: 37.2%<br>Engine: 26.6%<br>Galley/Hotel:36.2% | Top 5 causes of medical repatriation: musculoskeletal (23.2%), gastrointestinal (18.6%), injuries (15.1%), cardiovascular (7.0%), and dermatologic conditions (7.0%) Top 5 = > 70% of all repatriations. |
| Apostolatos (2017) [27] | Retrospective study.<br><br>Med Solutions International database.<br><br>Not classified using ICD codes. | International | 44 | 4 | M: 100%<br>F: 0% | NR | NR | NR | Number of confirmed cardiovascular cases was very low. There was only 1 heart attack and 1 pulmonary oedema complicating acute coronary syndrome. |
| Ballantine (1990) [23]<br><br>(*Offshore*) | Inspection of workers.<br><br>Not classified using ICD codes | UK continental shelf | 493 | 38 | NR | NR | NR | NR | The study of dental health of offshore workers shows that they have a considerable amount of untreated dental disease. |
| Bell (2009) [28] | Retrospective study<br><br>Data from P & O Princess Cruises International Fleet.<br><br>Not classified using ICD codes | Global | 25039 | 507 | NR | Mean age: 34 | NR | NR | The least likely nationality to be repatriated in this cohort is Filipino. Most common causes of medical repatriation were injury, GI, psychiatric, GU, and neurological. |

**Table 1 cont.** Characteristics of included studies

| Author and year | Study type & data source | Location | Sample size | Number of repats(n) | Sex (% of n) | Age (% of n) | Rank (% of n) | Occupation by Dept. (% of n) | Relevant results or findings |
|---|---|---|---|---|---|---|---|---|---|
| Cakir (2021) [29] | Retrospective study.<br><br>Telemedical Assistance Service of Turkey database.<br><br>Classified using ICD-10 | Turkish Search and Rescue Area | 4668 | 471 | NR | < 30: 25%<br>30-49: 53%<br>≥ 50: 22% | Officer: 35%<br>Non-officer: 65% | Deck: 63%<br>Engine: 31%<br>Galley: 6% | Incidents on board ships are more likely to lead to medical evacuations for the following characteristics of ships and seafarers: ships sailing in coastal waters, Turkish-flagged ships, and older ships, and seafarers who are non-officers, Turkish nationals, deck personnel, older, diagnosed with circulatory system diseases, and suffering injuries. |
| Cross (1985) [30] | Retrospective study.<br><br>Data logs from Motor Vessel *Miranda*.<br><br>Not classified using ICD codes. | Arctic fishing ground | 966 | 170 | NR | NR | NR | Report, not correlated with repats. | A total of 170 patients was repatriated, 138 directly from the trawler support ship. Illnesses accounted for 101 repatriations, the largest number being GI followed by MSK disorders, all but one presenting with severe backache. Illnesses most likely to necessitate repatriation were cardiological and psychiatric conditions. 69 trawlermen were repatriated after accidents. |
| Dethleff (2016) [17]<br><br>(*Offshore*) | Retrospective study.<br><br>Data provided by operator of the windfarm and related emergency protocols.<br><br>Not classified using ICD codes. | Wind farm in the North Sea | 39 | 39 | NR | NR | NR | NR | 49% of medevacs were related to traumatic injuries, whereas 41% were associated with acute diseases and 10% remained unclear. Cardiovascular and gastrointestinal disorders<br>accounted for 90% of internal medical cases. About 69% of the trauma was related to contusions, lacerations,<br>and cuts. The main body regions injured were limbs (~59%) and head (~32%) |
| Duffy (1996) [24]<br><br>(*Offshore*) | Retrospective study<br><br>Shell data for “medivacs” and “dentivacs” from 1988-1994.<br><br>Not classified with ICD codes. | North Sea | 3182 | 3182 | NR | NR | NR | NR | Dentivacs are a major cause of medical evacuations for Shell Expro and account for one of the largest percentage categories over the reporting period. |

**Table 1 cont.** Characteristics of included studies

| Author and year | Study type & data source | Location | Sample size | Number of repats(n) | Sex (% of n) | Age (% of n) | Rank (% of n) | Occupation by Dept. (% of n) | Relevant results or findings |
|---|---|---|---|---|---|---|---|---|---|
| Herttua (2021) [16] | Register-based study.<br><br>Danish-flagged merchant ships using the TMAS (telemedical assistance service) and Danish Maritime Authority databases.<br><br>Classified using ICD-10 | | 72,941 | 403 | M: 97%<br>F: 3% | <30: 18%<br>30-49: 48%<br>>50: 34% | Eng. officer: 2%<br>Deck officer: 16%<br>Non-officer: 82% | NR | Working as non-officer, older age and non-Danish EU nationality is associated with a higher risk of evacuations irrespective of the cause. In the medical examinations of seafarers, a special focus is needed on cardiovascular health among older employees. |
| Huerte (2023) [14] | Retrospective study.<br><br>Medical repatriations using data from medical records from OSM Shipping Company<br><br>Classified using ICD-11 | Global | NR | 924 | NR | NR | NR | NR | Majority of medical repatriations were attributed to injury (19.91%), MSK (18.4%), GI (16.56%), CV (8.77%), infectious (6.82%), GU (5.3%). Significantly, this study shows a decline in proportion of CV, GI, and GI cases over the span of the study. |
| Jaremin (1988) [31] | Retrospective 6-month study<br><br>Cruise ship physician's own records.<br><br>Not classified using ICD codes | Caribbean Sea and transit to Alaska. | 413 | 4 | NR | NR | NR | NR | Most prevalent diseases on a passenger ship were diseases of the respiratory system, diseases of the skin, and injuries. These account for 70% of medical consults. |
| Latournerie (2023) [25] | Retrospective epidemiological study between 2011 and 2019<br><br>Data from consultations with the French TMAS<br><br>Not classified with ICD codes | French TMAS coverage area | 1006 | 398 | M: 100%<br>F: 0% | NR | Officer: 9.5%<br>Non-officer: 90.5% | NR | Five factors were identified as being associated with the decision for disembarkation or evacuation: wound severity, wound location, ship location, photography availability, and staff medical training. |
| Lefkowitz (2015) [15] | Retrospective study.<br><br>Data provided by Future Care, Inc., a company that manages the health of seafarers globally and provides telemedicine services.<br><br>Not classified using ICD codes | International | 3921 | 61 | M: 98.4%<br>F: 1.6% | < 30: 31%<br>30-39: 31%<br>40-49: 21%<br>≥ 50: 16% | Officer: 46%<br>Non-officer: 49%<br>Unknown: 5% | Deck: 41%<br>Engine: 41%<br>Galley: 10%<br>Other: 8% | 61 repatriations over the study period (1.6% of cases). Most repatriations were due to illness (38; 62.3%) as opposed to injury (23; 37.7%). Back injuries and gastrointestinal illness were the most frequent causes of repatriations. Using logistic regression, nationality was identified as a significant risk factor for repatriation. |

**Table 1 cont.** Characteristics of included studies

| Author and year | Study type & data source | Location | Sample size | Number of repats(n) | Sex (% of n) | Age (% of n) | Rank (% of n) | Occupation by Dept. (% of n) | Relevant results or findings |
|---|---|---|---|---|---|---|---|---|---|
| Norman (1988) [32] (*Offshore*) | Retrospective study<br><br>Data extracted from various industrial reports and records as well as questionnaires.<br><br>Classified using ICD (1997) | UK continental shelf | 2162 | 2162 | NR | Mean age (injury): 28.3<br>Mean age (illness): 34.4 | NR | NR | Using the ICD, the digestive system was responsible for most evacuations for illness and of those, about half (115 evacuations) were for dental problems. Suspected fractures were responsible for about one third of those evacuated for an injury but injuries of hands and eye conditions were particularly common, accounting for 25% of all evacuations. |
| Oldenburg (2014) [33] | Cross-sectional survey<br><br>465 nautical officers participating in medical refresher course interviewed about their experience with medical emergencies that requires repatriation at sea.<br><br>Not classified using ICD codes | Global | 133 | 83 | NR | NR | NR | NR | Serious emergencies on board (leading to deviation to an emergency port call) are most frequently related to trauma or cardiovascular diseases. |
| Oliver (1981) [34] | Retrospective.<br><br>Data review of company medical records.<br><br>Classified using “modified” ICD codes | Global | 6630 | 110 | NR | NR | Officer: 22%<br>Non-officer: 78% | NR | Reasons for medical repatriation closely correlated those for medical attendance aboard, namely accidents and gastro-intestinal disease as the two major groups. |
| Ponsonby (2009) [35] | A review of published literature was supplemented with a summary of current practice in the industry.<br><br>Classified using ICD codes<br><br>*Data drawn from study from Health & Safety Executive UK | Global | 3979 | 3979 | NR | NR | NR | NR | Illnesses were reported to account for 55% of cases and injury for 45% of cases. In the last year of the study, illnesses accounted for 65% of all evacuations. The reasons for this were thought to be due to increased safety management and also a move away from exploration and construction towards operations and maintenance. |

**Table 1 cont.** Characteristics of included studies

| Author and year | Study type & data source | Location | Sample size | Number of repats(n) | Sex (% of n) | Age (% of n) | Rank (% of n) | Occupation by Dept. (% of n) | Relevant results or findings |
|---|---|---|---|---|---|---|---|---|---|
| Sae-Jia (2020) [36]<br><br>(*Offshore*) | Retrospective<br>Review of data of medical evacuation among industry from 2016-2019.<br><br>Classified using ICD-10 | Gulf of Thailand | 416 | 416 | M: 98.5%<br>F: 1.5% | < 30: 12%<br>30-39: 47%<br>40-49: 29%<br>50-59: 11%<br>> 59: 1% | NR | NR | The top 8 causes of Medevacs in the Gulf of Thailand were influenza 20.19%, injury and wound 7.45%, chickenpox 5.53%, fracture, dislocation, sprain, and strain 4.09%, urolithiasis 3.85%, dental caries 3.13%, acute appendicitis 2.88%, and low back pain 2.88%, respectively |
| Stilz (2022) [37]<br><br>(*Offshore*) | Observational prospective cohort study.<br><br>Data from US offshore installations that had access to telemedicine and offshore installations in UK and Malaysia waters that did not.<br><br>Classified using ICD-10 | Global | 645 | 66 | NR | NR | NR | NR | The availability of telemedicine was associated with a lower medical evacuation rate. A higher medical evacuation rate was associated with age older than 60 years, and contractor workers rather than employed workers, regardless of the availability of telemedicine. |
| Taylor (1993) [38]<br><br>(*Offshore*) | Retrospective study<br><br>Data compiled by the Minerals Management Service of the US Department of the Interior.<br><br>Not classified using ICD codes | Gulf of Mexico | 9 | 9 | M: 100% | Mean age: 35.9 | NR | NR | The offshore oil production environment is ideally suited to benefit from the advantages of air medical transport. In addition to typical medical illnesses,<br>patients in this environment are subject to occupation-related injuries and exposure to hazardous materials. |
| Thibodaux (2014) [18]<br><br>(*Offshore*) | Retrospective review.<br><br>Data of medical calls from 102 rigs/platforms in the US Gulf Coast from 2008 through 2012 with specific<br>analysis of medevacs<br><br>Not classified using ICD codes. | US Gulf Coast | 8046 | 397 | NR | NR | NR | NR | Medical evacuations from offshore oil installations are very costly and have significant inherent personal health risks. Inadequate or non-existent medical evaluations prior to deployment and after any significant interval medical change may contribute to the number of medical evacuations. |

**Table 1 cont.** Characteristics of included studies

| Author and year | Study type & data source | Location | Sample size | Number of repats(n) | Sex (% of n) | Age (% of n) | Rank (% of n) | Occupation by Dept. (% of n) | Relevant results or findings |
|---|---|---|---|---|---|---|---|---|---|
| Tomaszunas (1990) [39] | Retrospective study.<br><br>Data from Polish Ocean Lines from 1985 to 1989.<br><br>Not classified using ICD codes. | Global | NR | 354 | NR | < 30: 12%<br>31–40: 31%<br>41–50: 22%<br>51–60: 26%<br>> 60: 3%<br>NR: 6% | NR | Deck: 37%<br>Engine: 35%<br>Galley: 25%<br>Other: 3% | Serious disease requiring repatriation occurred about 4 times more frequently than injuries requiring repatriation. The most common diseases were diseases of the circulatory system, follow by mental disorders and nervous system, and genitourinary. |
| Waje-Andreassen (2020) [19]<br><br>(*Offshore*) | Prospective study.<br><br>Data collated from the air transport company's (Equinor) medical records and standardized forms filled out by SAR nurses during evacuations.<br><br>Not classified using ICD codes | North Sea | 381 | 381 | M: 88%<br>F: 12% | Mean age: 46 | NR | NR | 381 persons (88% men) were evacuated during the study period. Twenty-seven percent of missions were due to chest pain and 18% due to trauma. |
| Westlund (2011) [40] | Retrospective study.<br><br>Data from Swedish Radio Medical Database.<br><br>Classified using ICPC-2 | Global | 1290 (449 infectious) | 25 | NR | NR | NR | NR | Infectious conditions are a significant contributor to calls to the service and they can be more frequently treated on board than can other conditions. |
| Yuan (2022) [41] | Retrospective review<br><br>Data from all civilian SAR (search and rescue) and Heli-medivac activations by Royal Singapore Air Force over a 5-year period from 2016-2020 | Singapore Aviation SAR Region | 42 | 42 | M: 92.9%<br>F: 7.1% | Mean age: 47 | NR | NR | An analysis of these Heli-medevac cases revealed the 3 most common types of conditions encountered were acute coronary syndromes (26.2%); gastrointestinal conditions (16.7%) such as upper gastrointestinal tract bleeding, acute appendicitis, and intestinal obstruction; and neurologic conditions such as stroke and intracranial haemorrhage (14.3%) |
| **Case reports & case studies** | | | | | | | | | |
| Afandiyev (2022) [9] | Case report | Global | 42 | 42 | NR | NR | NR | NR | 9 seafarers evacuated with signs of poisoning. 3 crew members died on board prior to patrol ship arrival. The cause was due to a failure in ship safety requirements. Also provides data on three other incidents of poisoning. |

**Table 1 cont.** Characteristics of included studies

| Author and year | Study type & data source | Location | Sample size | Number of repats(n) | Sex (% of n) | Age (% of n) | Rank (% of n) | Occupation by Dept. (% of n) | Relevant results or findings |
|---|---|---|---|---|---|---|---|---|---|
| Fernandez--Palacios (2009) [42] | Case report | Canary Islands | 1 | 1 | Male | 28 | NR | NR | The hand had been revascularized thirteen hours after the accident and was still well circulated at repatriation 3 weeks later. |
| Kulkarni (2019) [43] | Case report | Pacific Ocean | 1 | 1 | Male | 34 | NR | NR | Medical aid to a seriously ill or injured sailor on high seas is always a problem. Means of evacuation and distance from port with medical facilities play a major role. |
| Kulkarni (2020) [8] | Case report | Arabian Sea | 1 | 1 | Male | 24 | NR | NR | Large number of seafarers hail from South East Asia and China where pork is consumed extensively. Screening every asymptomatic seafarer for neurocysticercosis is not possible. Instead, all reporting for PEME could be administered tab Albendazole 400 mg as a single dose broad spectrum anthelmintic as a cost effective measure. Food handlers should be additionally treated with anti-amoebic medication. |
| Lee (2015) [21] | Case report | NR | 1 | 1 | Male | 48 | Rating | NR | Telepsychiatry services may help identify high risk patients, improve quality of care, and potentially reduce costs to the client. |
| Montocchio--Buades (2018) [44] | Case report | Coastal waters off Djibouti | 1 | 1 | Male | 26 | NR | NR | This case highlights the risks and dangers of injury in the isolated environment of seafaring. It also highlights the importance of first aid trained staff with an emergency kit on board. |

Studies on offshore workers indicated under author as (Offshore); M – Male; F – Female; GI – gastrointestinal; GU – genitourinary; MSK – musculoskeletal; ICD – International Classification of Disease; ICPC – International Classification of Primary Care; NR – not reported; PEME pre-employment medical examination

**Table 2.** Types of illness and injury by International Classification of Disease 11th revision codes resulting in repatriation as a percentage of total repatriations

| Author and year | n | 01: Certain Infectious or Parasitic Diseases | 06: Mental, behavioural, or neuro-developmental disorders | 08: Diseases of the nervous system | 09: Diseases of the visual system | 10: Diseases of the ear or mastoid process | 11: Diseases of the circulatory system | 12: Diseases of the respiratory system | 13: Diseases of the digestive system | 14: Diseases of the skin | 15: Diseases of the MSK system or connective tissue | 16: Diseases of the genitourinary system | 22/23: Injury, poisoning or certain other consequences of/ external causes | Other/unknown |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Abaya (2015) | 6579 | 3.6% | 1.8% | 1.3% | 2.9% | 1.3% | 8.1% | 3.0% | 17.7% | 5.6% | 19.1% | 8.9% | 21.4% | 5.1% |
| Abaya (2018) | 840 | 1% Cargo 3% Passenger | 2% Cargo < 1% Passenger | 1% Cargo 1.5% Passenger | 6% Cargo 7.5% Passenger | 4% | 4% Cargo 13% Passenger | 3% Cargo 1% Passenger | 23% Cargo 15% Passenger | 10% Cargo 8% Passenger | 20% | 6% Cargo 7% Passenger | 18% Cargo 8% Passenger | < 1% Cargo 7% Passenger |
| Abaya (2023) | 6526 | 2.8% | 2.3% | 1.4% | 4.1% | 1.0% | 7.1% | 3.2% | 19.4% | 7.0% | 23.3% | 6.6% | 15.1% | 5.6% |
| Apostolatos (2017) | 4 | – | – | – | – | – | 50% | – | – | – | – | – | 25% | 25% |
| Ballantine* (1990) | 38 | – | – | – | – | – | – | – | 100% | – | – | – | – | – |
| Bell (2009) | 507 | – | 8.2% | 4.7% | – | – | – | – | 16.0% | – | – | 5.7% | 39.8% | 25.4% |
| Cakir (2021) | 471 | – | – | – | – | – | 12.7% | 4.0% | 8.5% | – | 2.3% | – | 39.7% | 32.7% |
| Cross (1985) | 170 | 2.4% | 8.2% | – | – | 0.6% | 7.6% | 7.6% | 15.9% | 0.6% | 11.8% | 4.7% | 40.5% | – |
| Dethleff* (2016) | 39 | – | – | 2.6% | – | – | 10.2% | 2.6% | 10.2% | 7.7% | 7.7% | – | 48.7% | 10.2% |
| Duffy*(1996) | 3182 | – | – | – | – | – | – | – | 11.2% | – | – | – | – | 88.8% |
| Herttua (2021) | 403 | – | – | – | – | – | 19% | – | 14% | – | – | – | 27% | 40% |
| Huerte (2023) | 924 | 6.8% | 1.7% | 2.4% | 3.5% | 1.3% | 8.8% | 3.1% | 17.9% | 5.2% | 18.4% | 5.3% | 19.9% | 5.7% |
| Jaremin (1988) | 4 | – | – | – | – | – | – | 25% | – | – | 25% | – | 50% | – |
| Latournerie (2023) | 398 | – | – | – | – | – | – | – | – | – | – | – | 100% | – |
| Lefkowitz (2015) | 61 | – | 3.3% | – | 3.3% | 4.9% | 6.6% | 22.9% | 6.6% | 3.3% | 8.2% | 37.7% | 3.3% | – |
| Norman* (1988) | 2162 | 1.6% | 1.9% | 4.4% | | | 1.9% | 5.4% | 11.1% | 1.5% | 7.2% | 1.2% | 63.5% | 0.2% |

**Table 2 cont.** Types of illness and injury by International Classification of Disease 11th revision codes resulting in repatriation as a percentage of total repatriations

| Author and year | n | 01: Certain Infectious or Parasitic Diseases | 06: Mental, behavioural, or neuro-developmental disorders | 08: Diseases of the nervous system | 09: Diseases of the visual system | 10: Diseases of the ear or mastoid process | 11: Diseases of the circulatory system | 12: Diseases of the respiratory system | 13: Diseases of the digestive system | 14: Diseases of the skin | 15: Diseases of the MSK system or connective tissue | 16: Diseases of the genitourinary system | 22/23: Injury, poisoning or certain other consequences of/ external causes | Other/unknown |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Oldenburg (2014) | 83 | – | – | 8.4% | – | – | 14.5% | 12.1% (ICD 12/14) | 15.7% | Incl. in ICD–12 | – | 4.8% | 44.6% | – |
| Oliver (1981) | 110 | – | 11.8% | – | – | – | 13.6% | 8.2% | 22.7% | – | 4.6% | 6.4% | 28.2% | 4.6% |
| Ponsonby (2009) | 3979 | 4.5% | 2.2% | 4.7% | – | – | 1.5% | 7.8% | 14.1% | 2.1% | 9.4% | 2.5% | 40.1% | 8.0% |
| Sae-Jia* (2020) | 416 | 12.3% | 0.7% | 2.9% | 3.6% | 1.4% | 2.4% | 22.8% | 11.8% | 5.3% | 5.8% | 5.8% | 15.6% | 9.6% |
| Stilz* (2022) | 66 | – | – | – | 7.6% | – | – | 16.7% | 7.6% | – | 9.1% | – | 15.2% | 43.9% |
| Taylor**(1993) | 9 | – | – | – | – | – | 22.2% | – | – | – | – | – | 77.8% | – |
| Thibodaux* (2014) | 397 | 6.6% | 0.7% | 10.1% | – | – | 34.3% | 2.5% | 11.8% | – | – | 0.3% | 23.9% | 9.8% |
| Tomaszunas | 354 | – | 16.1% | | | – | 21.5% | – | **17.8%** | – | – | 7.9% | 18.9% | 17.8% |
| Waje-Andreassen* (2020) | 381 | 7.9% | 1.0% | 7.9% | – | – | 36.2% | – | 19.7% | – | – | – | 17.8% | 7.9% |
| Westlund (2011) | 25 | 8.0% | – | – | 4.0% | 4.0% | – | 12.0% | 60.0% | 8.0% | – | 4.0% | – | – |
| Yuan (2022) | 42 | – | – | – | – | – | 42.9% | 2.4% | 16.7% | – | – | – | 26.2% | 11.9% |
| Totals | 27773 | 2.9% | 1.9% | 1.9% | 2.2% | 1.1% | 6.2% | 3.8% | 15.9% | 4.0% | 13.5% | 5.1% | 25.2% | 16.58% |
| **CASE REPORTS** | | | | | | | | | | | | | | |
| Afandiyev (2022) | 42 | – | – | – | – | – | – | – | – | – | – | – | 42 | – |
| Fernandez-Palacios (2009) | 1 | – | – | – | – | – | – | – | – | – | – | – | 1 | – |

**Table 2 cont.** Types of illness and injury by International Classification of Disease 11th revision codes resulting in repatriation as a percentage of total repatriations

| Author and year | n | 01: Certain Infectious or Parasitic Diseases | 06: Mental, behavioural, or neuro-developmental disorders | 08: Diseases of the nervous system | 09: Diseases of the visual system | 10: Diseases of the ear or mastoid process | 11: Diseases of the circulatory system | 12: Diseases of the respiratory system | 13: Diseases of the digestive system | 14: Diseases of the skin | 15: Diseases of the MSK system or connective tissue | 16: Diseases of the genitourinary system | 22/23: Injury, poisoning or certain other consequences of/ external causes | Other/unknown |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Kulkarni (2019) | 1 | 1 | – | – | – | – | – | – | – | – | – | – | – | – |
| Kulkarni (2020) | 1 | 1 | – | – | – | – | – | – | – | – | – | – | – | – |
| Lee (2015) | 1 | – | 1 | – | – | – | – | – | – | – | – | – | – | – |
| Montocchio-Buades (2018) | 1 | – | – | – | – | – | – | – | – | – | – | – | 1 | – |

*represents study of offshore workers; other includes most other categories from ICD-11; categories included in other: 02 neoplasms, 03 diseases of the blood or blood-forming organs, 04 diseases of the immune system, 05 endocrine, nutritional or metabolic diseases, 07 sleep-wake disorders, 17 conditions related to sexual health, 18 pregnancy, childbirth or the puerperium, 19 certain conditions originating in the perinatal period, 20 developmental anomalies, 21 symptoms, signs or clinical findings, not elsewhere classified; categories not included 24 factors influencing health status or contact with health services

Institutes of Occupational Health and Safety in European countries have collected and analysed information on the workers' environment and health using questionnaires, but seafarers, fishermen, dockworkers, and offshore workers are not represented in these surveys." The well-documented risks of accident or injury among seafarers coupled with the relative paucity of data to support improvement in screening and treatment delivery add to the vulnerability of this working population. The ILO Guidelines on the Medical Examination of Seafarers [11] were published in 2013 and our current review may assist on the ongoing development and updating of such guidance from an occupational medicine viewpoint.

We noted three major observations from this literature review. Firstly, the published data on repatriations is limited in geographic representation, research methodology, and does not capture the global burden of repatriation among occupational seafarers and offshore workers. Secondly, this is one of the first reports exploring offshore workers and serves as a potential point of future comparison between offshore work environments and seafarers. Finally, we have identified the medical causes of repatriation using ICD-11 codes.

## REPATRIATION RESEARCH AND LITERATURE

It is estimated by Faurby et al that 1.7% of deployments end in a repatriation, for medical reasons or otherwise [2]. Even if this number is an overrepresentation of the global seafarer population of close to two million workers, then the population of this study, (n = 28,170 repatriations), covering a span of close to forty years and multiple voyages per year, is a small fraction of the total population exposed to seafaring or offshore work. The total exposure to seafaring and offshore work would be estimated to be the total seafaring population x days at sea per worker. Such global data is not available. The results of this scoping review demonstrate clearly that there is a significant population of seafarers requiring medical repatriation that would benefit from a deeper understanding of the medical and occupational factors contributing to evacuation.

The most common inconsistency in the literature was reporting of demographic and occupational characteristics. The absence of a clearly defined study population limited the number of included papers. For example, there were several studies excluded that blended both commercial seafarers and another population without the ability to differentiate these groups in the published data (e.g. military plus passengers). Only 22% of the included studies reported on the specific occupation of the repatriated seafarer. The array of occupations among seafarers and offshore workers come with differing occupational risks and medical screening should be representative of these risks to identify individual and job-related risk factors for injury or illness. More recent published work has included some additional data on seafarers however as we noted 5 of 14 studies published in 2015 or later provided data on occupation and/or rank as opposed to only 2 of 13 studies published prior to 2015. An example of this improvement is the inclusion of occupation data by Abaya et al. in 2023 [12], as compared to their prior work in 2015 [13]. These studies were very similarly designed but the inclusion of occupational information enhanced the utility of the data from an occupational medicine perspective. Conversely, Huerte et al. [14] did not include demographic data even though the data base was drawn from medical records that would reasonably include at least sex and age. Lefkowitz et al. [15] showed in a study of 61 repatriations that the only significant aggravating risk factor for repatriation was the nationality of the seafarer. Herttua et al. [16] show clearly that age and non-officer occupation (vs officer) were both associated with an increased risk of repatriation. It further showed that the odds ratio between non-officer and officer is highest for repatriations due to external causes, such as physical injuries. They speculate that the difference is influenced by lifestyle factors and occupational hazards. Saguro et al. [3] also addressed this issue and show an increased risk of injury and disease in non-officers compared to officers. It is clear that these demographic and occupational risk factors need to be analysed across a larger population to assist in more robust epidemiology of injury and disease in the seafaring population.

There is a paucity of evidence for females due to the largely male composition of the seafaring workforce. The IMO reports a 45.8% increase in female seafarers since 2015 so this increasing population in the workforce requires additional research [1]. For the benefit of enhancing the data to support proper screening tools, it is suggested that future projects related to medical repatriations focus on ensuring robust reporting of demographic information for their populations. Furthermore, less than half of the studies reported illness in accordance with ICD-11. Due to the international nature of the seafaring, illness and injury should be reported in a manner that is globally recognizable and transferable.

## MEDICAL CAUSES OF REPATRIATION

The most common cause of medical repatriation identified in our review was physical injury. This is consistent across most of the large population-based studies. The types of injuries have been studied in detail including by Dethleff et al. [17] and Huerte et al [14]. Huerte et al. [14] breaks down each of the top causes of repatriation, including ICD-22/ICD-23, into more specific diagnoses which adds more

depth to the analysis. From this study, hand injuries were by far the most prevalent type of injury. From an occupational safety perspective, this is a crucial finding in an effort to develop appropriate safety standards or prevention measures to minimize the risk of injury or illness. In contrast to the seafaring workers, some of the studies that assessed offshore platforms showed that injury was not the leading cause of repatriation [18, 19]. In these studies, the leading cause of repatriation was ICD-11 (diseases of the cardiovascular system). There are a few factors that could account for this difference including stability of the working platform and type of work, but there may also be differences in safety culture, medical resources, or access to telehealth between the two work environments and this should be investigated in more depth in future research.

Mental health was not identified in the published literature as a significant cause of repatriations. However, Jonglertmontree et al. [20] recently published a scoping review on mental health of seafarers and concluded that mental illness has long been prevalent among those who work at sea but is understudied. That is consistent with the findings of this scoping review, where only one case study focused specifically on mental health as a cause for repatriation. The case study by Lee et al. [21] demonstrated the benefits of a strong telemedicine construct to assist during mental health crises at sea. Our scoping review shows that only 1.9% of published repatriations were caused by illnesses that fall into ICD-06 which includes mental illness. This may represent underreporting, lack of published research or both.

Our review estimates that diseases of the cardiovascular, respiratory, and gastrointestinal systems accounted for 26.2% of the total medical repatriations. Diagnoses among each of these systems may present with overlapping constellations of clinical signs and symptoms. Furthermore, diagnoses that arise within each organ system could indicate severe or life-threatening disease or could also be relatively benign conditions. Due to the cost and disruption of repatriation [2] ships' crews and companies inevitably face both a clinical and operational decision point. Challenges with differentiating between a benign diagnosis from a severe one could lead to excessive repatriations. Conversely, decisions to not repatriate could arise when a timely and accurate diagnosis of a more serious condition is not identified. In both circumstances the expertise of the crew to make the right decision would be tested. Advances in onboard technology including point of care ultrasound (POCUS), and inexpensive portable electrocardiograms have the potential to improve healthcare outcomes in these populations [22] Many of the papers in this review either studied or referenced telehealth consultations which is another resource that could be utilized on all seagoing vessels that lack adequate medical capability at sea.

## LIMITATIONS

There are several limitations to consider in this study. The intent to include a large literature-based global data set led to several studies being included that were not epidemiologically broad in scope. Specifically, some studies focused on a specific medical cause of repatriation, rather than studying 'all medical causes'. For example, the studies by Ballantine et al. [23] and Duffy et al. [24] reported only dental causes of repatriations which does not allow for the relative contribution of ICD-13 classified diseases towards repatriation. In the Duffy et al. paper specifically, the unclassified evacuations were included under "unknown cause" and this study alone contributed over 61% (authors' calculation) of the total "unknown causes" of repatriation tabulated in this review. Latournerie et al. [25] focused specifically on evacuation due to acute injury. The goal of this review was to report on the types of studies and the diagnoses that led to repatriation among seafarers and offshore workers. However, the relative contribution to repatriation of each ICD category is limited to only published repatriation in our review, therefore cannot quantified in further detail.

The authors of this review limited the included studies to those that were published in English. Considering the Philippines, the Russian Federation, Indonesia, India, and China are the largest suppliers of ratings and officers, there may be vast amounts of data published in languages other than English that were not included [1]. Another limitation is the proprietary nature of the data that needs to be studied. Most of the studies used data from crewing agencies or shipping/cruise lines. This data is not open source so studies may be limited by the amount of data that companies provide. Furthermore, our review retrieved only peer reviewed and published data, which is a limitation in studying workers among global private enterprises.

## CONCLUSIONS

This scoping review on the medical causes of repatriations in seafarers and offshore workers demonstrates a large, vulnerable population that was underrepresented in the published literature. The population size in the available research was a small representation of the total demographic that needs to be studied. It highlights the shortcomings in the available literature, most notably, a lack of demographic information to properly assess risk factors for specific occupational illnesses and injuries. The data indicates that injuries, diseases of the gastrointestinal system, and disorders of the musculoskeletal system are the most commonly reported medical causes of repatriation in the literature.

It is recommended that any future epidemiological studies relating to medical causes of repatriation place an emphasis on demographics and specific occupations

experiencing injury and illness. It is also the hope that this study will prove useful in continuing to advance medical care for sea-based occupations.

## ARTICLE INFORMATION AND DECLARATIONS

**Author contributions:** Both authors (JB and WSJ) contributed to the conception, protocol development, search, review, drafting and approval of the final version of this paper.

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**Conflict of interest:** JB and WSJ have no conflicts to disclose.

**Supplementary material:** We have included our search strategy in Appendix 1 as a supplemental file.

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# Primary healthcare in island regions: A comprehensive analysis of trends, insights and future directions

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## ABSTRACT

***Background:*** *Primary healthcare in island regions is a critical component of global health systems, yet it faces unique challenges due to geographical isolation, resource constraints and sociocultural factors.*

***Aims:*** *This study aimed to systematically analyze the global research landscape of primary healthcare in islands through a bibliometric analysis.*

***Material and methods:*** *A comprehensive search was conducted to identify relevant publications using Scopus as the primary database. Keyword analysis, co-authorship networks and citation analysis were employed to explore research trends, collaboration patterns and influential authors and institutions.*

***Results:*** *The results revealed a significant increase in research output over the past few decades, with the United States, Spain and Australia emerging as leading contributors. Key research themes included access to care, health workforce, chronic disease management and health promotion. Collaborative research networks were identified, particularly among researchers from island nations and developed countries. The analysis also highlighted the growing importance of digital health technologies in addressing the challenges of island healthcare.*

***Conclusions:*** *Research on island primary healthcare has grown steadily since 1972, with key contributions from the United States, Spain and Australia. Major themes include clinical care, health systems and policy. Trends evolved from clinical to systemic and demographic focuses, with future directions emphasizing digital technologies and participatory methods. These findings inform evidence-based policies to enhance island health services.*

*(Int Marit Health 2025; 76, 2: 115–125)*

**Keywords: primary healthcare; islands; health system; research landscape; bibliometrics analysis**

## INTRODUCTION

Primary healthcare is an integral foundation of the health system and is essential for improving the health status of communities, especially on islands [1]. As the frontline of health services, primary healthcare is a major contributor to achieving Universal Health Coverage (UHC), but its implementation in island regions faces unique challenges related to accessibility and equity of care [2, 3]. Research on primary healthcare in islands has shown a significant increase in recent decades, reflecting the global urgency to strengthen health systems in remote areas [3–5]. The geographical characteristics of islands create specific

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challenges in health service delivery, including limited access, unequal distribution of health workers and logistical constraints in the provision of medicines and medical devices [6].

The development of health technology and telemedicine has brought substantial changes in the delivery of primary healthcare in the islands [7]. The implementation of digital solutions in primary healthcare shows the potential to overcome geographical barriers, although there are still constraints related to infrastructure and community digital literacy [8]. A study conducted in the Australian archipelago showed that telemedicine can improve community access to specialist services through remote consultations [9]. International collaboration in primary health system strengthening in the Islands is increasing, driven by the need to share knowledge and resources [10]. Global partnership programs have contributed to the development of health service delivery models that are adaptive to island contexts, as demonstrated in the World Health Organization (WHO) study in the Pacific region [11].

Evaluation of primary healthcare quality in islands faces methodological challenges due to their unique geographical and socio-cultural contexts [12]. The framework developed needs to consider indicators specific to the island context, including accessibility, availability of health workers and sustainability of services [13]. However, the health economics of primary healthcare delivery in islands is of particular concern given limited resources and high operational costs [14]. Studies in the Pacific islands show that investments in primary health system strengthening can generate long-term positive economic impacts, especially in disease prevention and health promotion [15].

The development of primary health research in the Islands encompasses various aspects, ranging from service delivery models to program evaluation [16]. However, comprehensive bibliometric analysis of research trends in this particular field is limited. An in-depth understanding of publication patterns, research collaborations and thematic trends can provide valuable insights for future research policy or practice improvements [17]. Through a systematic bibliometric analysis, this review aims to identify trends, patterns and gaps in research on primary healthcare in the islands. This present report aims to address these gaps by conducting a systematic bibliometric analysis of the published literature.

## MATERIAL AND METHODS

This review was started by identifying keywords used in the Scopus database for „primary healthcare" and „islands".

### MINING DATA VIA SCOPUS

Published article data was collected from Scopus database using a combination of keywords [TITLE-ABS-KEY („Primary Health Care") AND TITLE-ABS-KEY („Islands")] AND [LIMIT-TO (SRCTYPE, „j") OR LIMIT-TO (SRCTYPE, „p")] AND [LIMIT-TO (DOCTYPE, „ar") OR LIMIT-TO (DOCTYPE, „re") OR LIMIT-TO (DOCTYPE, „cp")] as advance query. Document type was restricted to article type, only original articles, reviews and conference papers were included. Book and book chapters were excluded from the analysis.

### RECORD IDENTIFIED AND DATA PURGING

All documents identified from the search results were recorded and organized properly in the Excel software. Before further analysis, the collected data was cleaned and filtered using OpenRefine software version 3.8.2 to ensure the quality and relevance of the collected data.

### DATA VISUALIZATION

The data obtained were then presented visually using software such as Tableau version 2024.2, Vos Viewer 1.6.20 and R studio 2024.4.1 to facilitate data synthesis and interpretation.

## RESULTS

### GENERAL INFORMATION

As detailed in Figure 1, the research on primary healthcare in the Islands has been documented from 1972 to 2024. During this time, a total of 724 scientific articles were published through 384 different academic journals and other research outlets. A statistical analysis revealed intriguing growth dynamics, with an annual increase of 6.03%. The mean age of scientific articles in this field is 16.9 years, with each publication being cited an average of 16.46 times. The findings of this analysis demonstrate the sustainability and relevance of island health studies.

The pattern of collaboration between researchers exhibited an intriguing trend, with each publication involving, on average, six contributors. A total of 148 articles were produced by a single author. A total of 19.61% of the publications were the result of cross-country collaborations, indicating the existence of an active global research network. Of the total of 3784 authors, 120 were single authors, indicating a clear dominance of collaborative work.

The majority of publications were in the form of articles (667), followed by review articles (46) and conference papers (11), indicating a strong preference for publication in the form of journal articles. The substantial number of keywords (Keywords Plus: 4362; Author's Keywords: 1183) reflects the diversity of topics and approaches in primary healthcare research in the Islands.

### ANNUAL PUBLICATION GROWTH

Figure 2 presents the annual publication growth, and there has been a notable expansion in the number

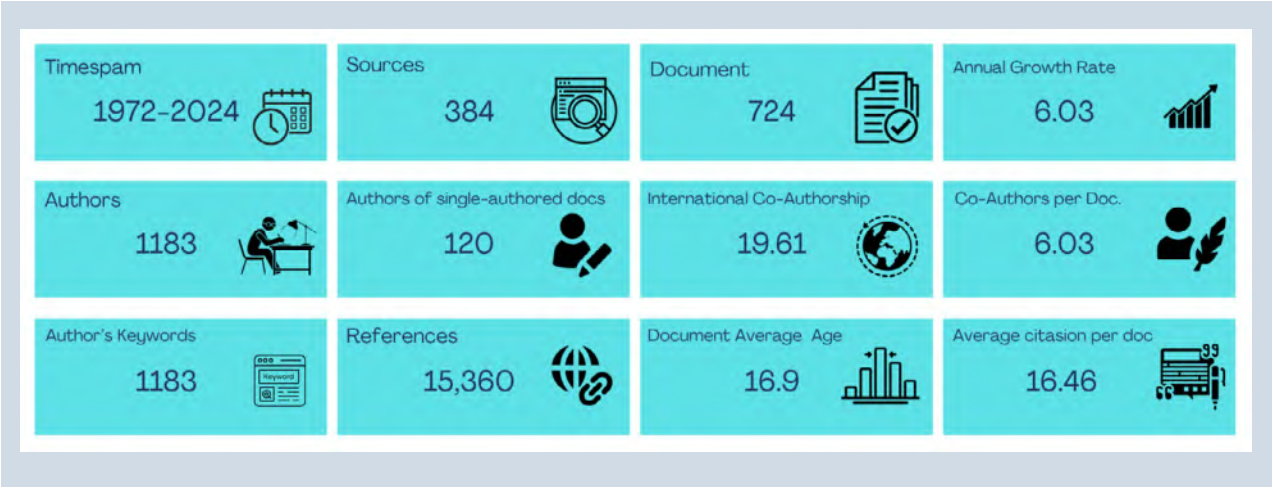


**Figure 1.** Infographic on the development of primary healthcare research in island regions 1972–2024

of publications. This is evidenced by the findings of the bibliometric analysis, which indicate a substantial increase in the number of publications since 1972. The number of scientific articles published increased markedly during the 2000s, with a particularly rapid growth phase until 2024. The initial phase of research (1972–1980) was distinguished by a relatively low level of output, with only two or three scientific articles published annually. This reflected the initial establishment of health studies in the archipelago when conceptual and methodological frameworks were still being developed.

The period between 1981 and 2000 represented a pivotal point in the evolution of this study. For the subsequent two decades, there was a notable surge in research productivity, with an average of six to fifteen papers published annually. This period was characterized by a phase of collaboration and the consolidation of the foundations of island health research. There has been a notable increase in output since 2000, with the highest peaks in 2021 (37 publications), 2015 (30 publications) and 2023 (30 publications). This trend suggests that island health issues are receiving increasing global attention, supported by increased international collaboration and research funding.

## PUBLICATION DISTRIBUTION BY COUNTRY

The results of the bibliometric analysis, as shown in Figure 3, demonstrate that the United States is the country with the highest number of publications, with 167, followed by Spain (84) and Australia (72). This reflects the dominance of developed countries in this study. This ranking reflects the superior research infrastructure and funding available in these countries. The notable participation of island nations such as New Zealand (57), Papua New Guinea (14) and Fiji (10) illustrates the active role of countries that directly face health challenges in island regions. This pattern indicates an awareness of the importance of locally-based research. Contributions from developing countries such as Indonesia (15), Brazil (14) and India (10) indicate a more inclusive global effort in addressing island health issues. This broad geographic distribution reflects the complexity and universality of health challenges in island regions.

## MOST INFLUENTIAL AFFILIATES BY NUMBER OF PUBLICATIONS

An analysis of the top 10 affiliations in publications on primary health in the Islands reveals intriguing institutional patterns in knowledge production, as presented in Table 1. The distribution of these publications indicates that some institutions have cultivated particular expertise and robust research programs in this domain. The preponderance of certain institutions is indicative of substantial investment in research infrastructure and ongoing advancement of research capacity.

Based on research productivity, the University of Auckland emerged as the foremost institution, responsible for the production of 93 scientific papers. Subsequently, the University of Crete produced 76 publications, while the University of Otago produced 43. This pattern reflects the substantial influence of universities situated on or close to the islands. This concentration reflects the specialized focus of these institutions on island health issues. The involvement of medical institutions such as Brown Medical School (22) and The Warren Alpert Medical School (16) exemplifies the integration between academic research and clinical practice. It is of great importance that this collaboration ensures the practical application of research in healthcare.

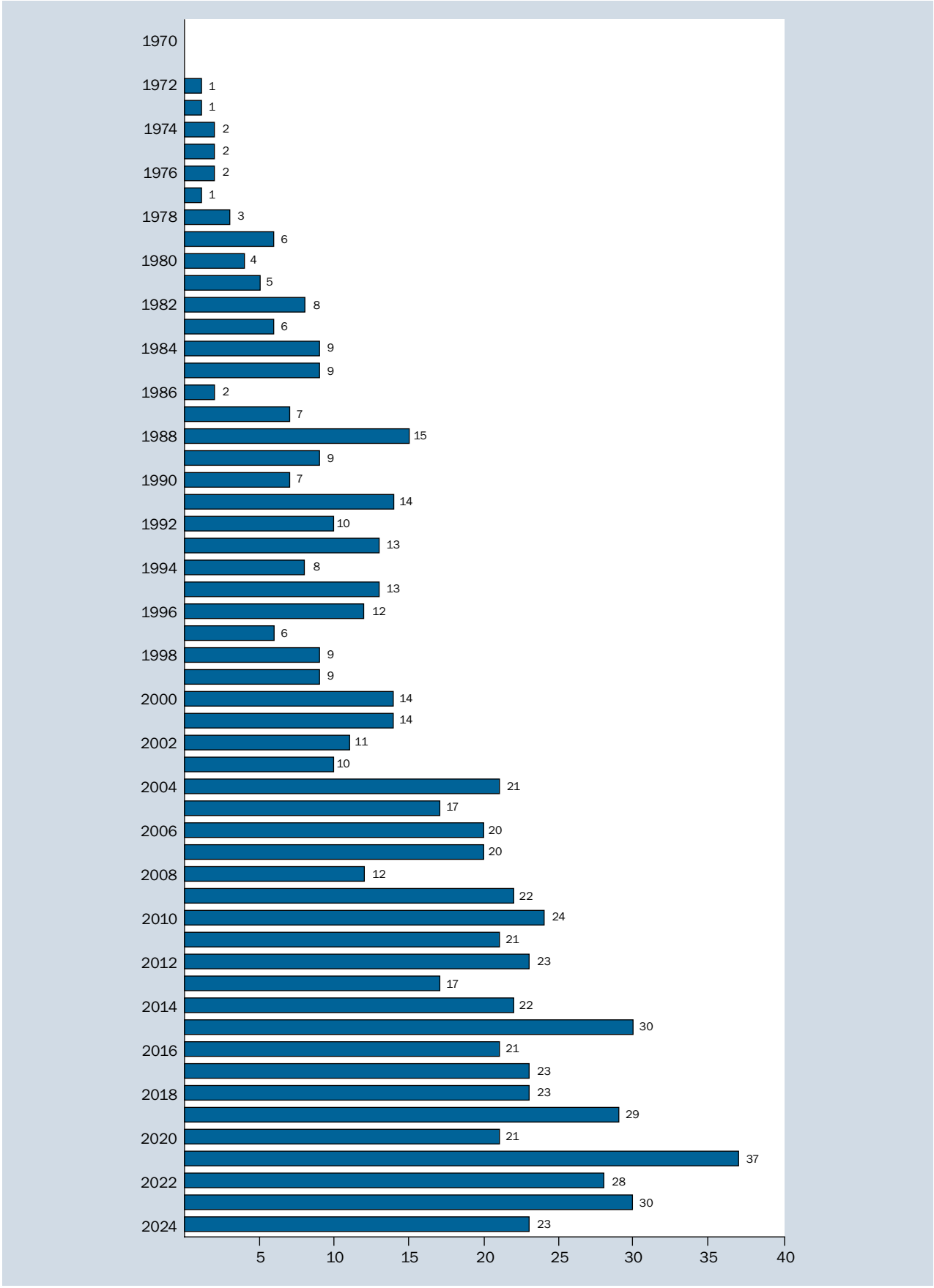


**Figure 2.** Trends in primary healthcare research publications in island regions by year (1972–2024)

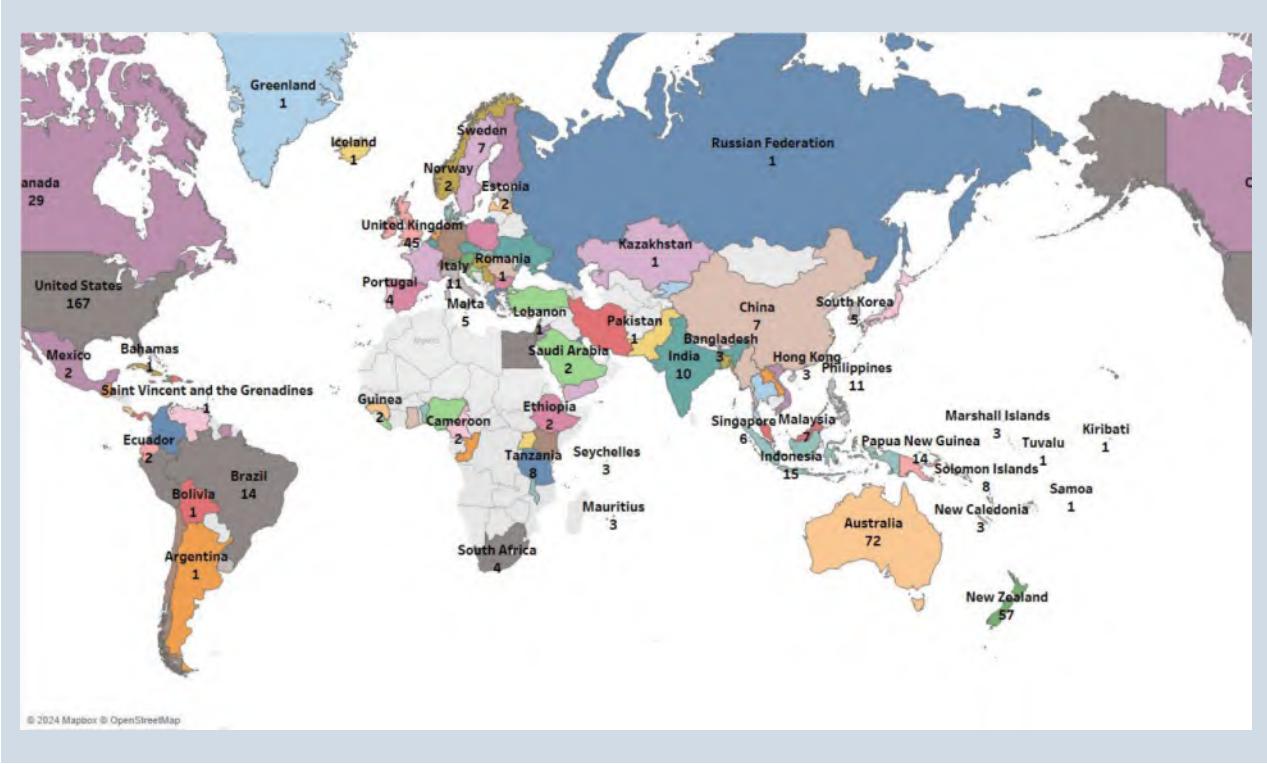


**Figure 3.** Geographic distribution of primary healthcare research publications in the islands

**Table 1.** The top ten institutions with the most publications in primary healthcare research in the Islands region

| Institution | Number of publications | Country |
|---|---|---|
| University of Auckland | 93 | New Zealand |
| University of Crete | 76 | Greece |
| University of Otago | 43 | New Zealand |
| Brown University | 42 | United States |
| University of New South Wales | 28 | Australia |
| The University of The West Indies | 23 | Karibia |
| Brown Medical School | 22 | United States |
| University of the West Indies | 19 | Karibia |
| University of Melbourne | 18 | Australia |
| Imperial College London | 16 | United Kingdom |

The active participation of government health agencies and international organizations, such as the Ministry of Health (13) and WHO, demonstrates a multi-stakeholder approach to addressing health challenges in the archipelago. This pattern of affiliation also illustrates the geography of knowledge in primary healthcare in the Islands. Contributions from different institutions indicate a distribution of expertise that may correlate with the geographical location of the islands studied. It is important to understand how knowledge in this field is generated and distributed spatially.

Table 2 presents the mapping of publication chains, which revealed intriguing patterns in the dissemination of research findings. The analysis of the ten most-cited journals revealed evident trends in the selection of publication sources, reflecting researchers' strategies to reach the optimal audience for island health studies. Maternal and Child Nutrition documented the highest number of publications (28), followed by the Journal of Nutrition (25) and PLOS ONE (20), indicating a pronounced emphasis on nutrition and maternal-child health concerns in the Islands areas [18].

The diversity of journals covering various aspects, including public health, clinical nutrition and health policy, illustrates a multidisciplinary research approach. This is evident from the significant contributions of journals such as the Food and Nutrition Bulletin (13) and BMJ Open (7). The existence of these influential journals also demonstrates the maturation of primary health research in the Islands as a distinct research domain. The distribution of publications in specific journals helps to establish coherence in the literature and makes it easier for researchers to keep up with the latest developments in the field. Furthermore,

**Table 2.** The top ten most frequently published journals in primary healthcare research in the Islands

| Journal | Doc | Q | Main Fields | Publisher |
|---|---|---|---|---|
| Medicine And Health, Rhode Island | 33 | Q4 | Medicine (General) | Rhode Island Medical Society |
| International Journal of Environmental Research and Public Health | 16 | Q1 | Public Health, Environmental & Occupational Health | MDPI |
| Rhode Island Medical Journal | 16 | Q4 | Medicine (General) | Rhode Island Medical Society |
| New Zealand Medical Journal | 15 | Q3 | Medicine (General) | New Zealand Medical Association |
| Papua And New Guinea Medical Journal | 15 | Q4 | Medicine (General) | Medical Society of Papua New Guinea |
| BMJ Open | 14 | Q1 | Medicine (General) | BMJ Publishing Group |
| Revista Panamericana De Salud Publica/Pan American Journal of Public Health | 14 | Q2 | Public Health | Pan American Health Organization |
| Bulletin of The World Health Organization | 12 | Q1 | Public Health, Environmental & Occupational Health | World Health Organization |
| BMC Health Services Research | 11 | Q1 | Public Health | BioMed Central (Springer Nature) |
| Journal of Primary Health Care | 11 | Q3 | Primary Health Care | Royal New Zealand College of General Practitioners |

BMC — Biomedical Central; BMJ — British Medical Journal; Doc — document; MDPI — Multidisciplinary Digital Publishing Institute; Q — Quartile

**Table 3.** The top ten contributing authors to primary healthcare research in the islands

| Author | Doc | Country | H Index | Main affiliation | TC | AF | PY Start |
|---|---|---|---|---|---|---|---|
| Christos D. Lionis | 14 | Greece | 9 | University of Crete Medical School | 143 | 2.27 | 2001 |
| Paul F. George | 8 | United States | 4 | The Warren Alpert Medical School | 37 | 2.01 | 2011 |
| Joan Llobera-Cánaves | 8 | Spain | 5 | Primary Care and Health Promotion (RICAPPS) | 83 | 1.49 | 1998 |
| Anthony C. Dowell | 7 | New Zealand | 7 | University of Otago | 134 | 1.32 | 2000 |
| Michael Stein D.Md | 7 | United States | 7 | The Warren Alpert Medical School | 455 | 2.19 | 1993 |
| Magdalena Esteva | 6 | Spain | 5 | Hospital Universitario Son Espases | 85 | 0.53 | 2007 |
| Jackson Rod | 6 | New Zealand | 6 | The University of Auckland | 1848 | 0.57 | 2007 |
| Vivier, P.M. | 6 | United States | 4 | Brown University | 70 | 1.40 | 1995 |
| Armando J. Aguirre-Jaime | 5 | Spain | 4 | Farmacia comunitaria de Santa Cruz de Tenerifedarw | 24 | 1.04 | 2017 |
| Anthony J. Alario | 5 | United States | 4 | UMass Memorial Medical Center | 62 | 1.20 | 1995 |

AF — articles fractionalized; Doc — document; PY — publication year; TC — total citation

it facilitates the systematic accumulation of knowledge and the development of solid interdisciplinary research paradigms.

## MOST INFLUENTIAL AUTHORS BY NUMBER OF PUBLICATIONS

Table 3 shows the ten authors that have made notable contributions to primary healthcare research in the Islands. The preponderance of publications by these leading authors suggests a sustained research focus and dedication to the development of health systems in the Islands. This is indicative of the concentration of specialization and expertise within a core group of researchers in the field. The bibliometric analysis demonstrates that Christodus D. Lionis of the University of Crete Medical School is the most prolific author,

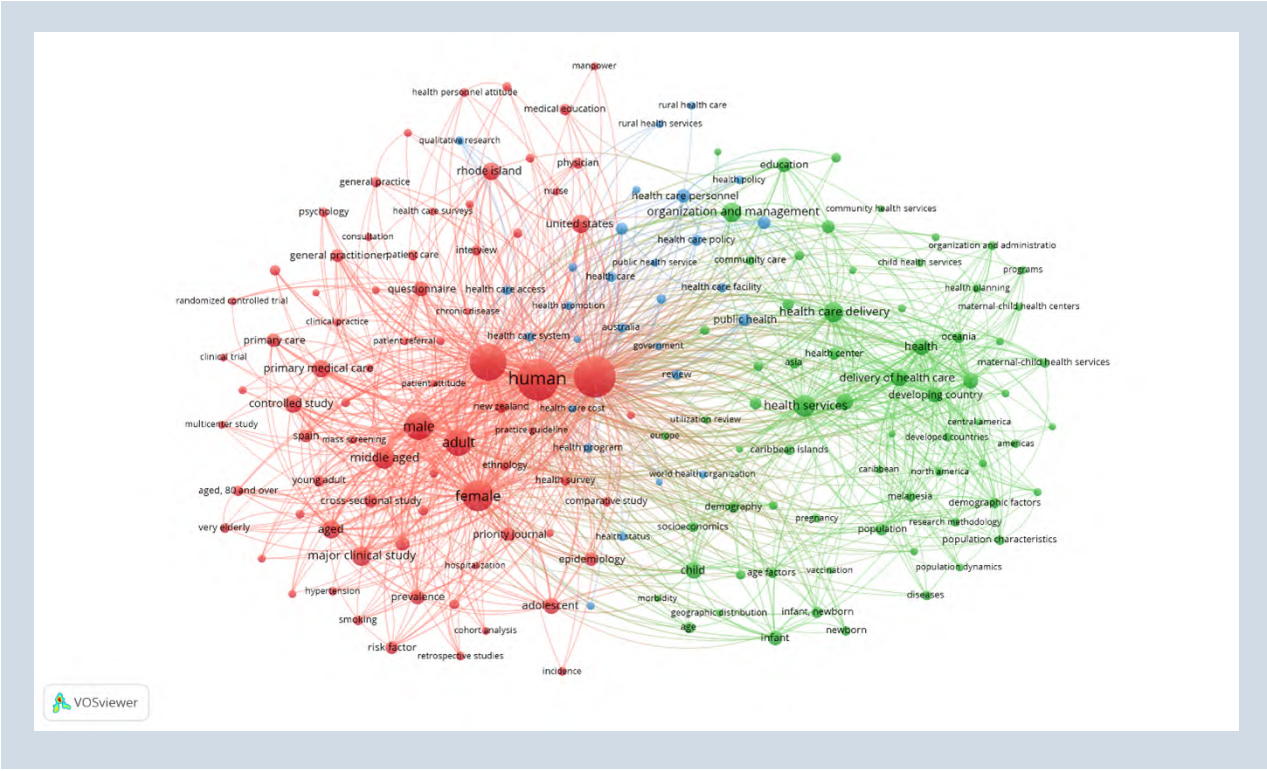


**Figure 4.** Visualization of the keyword network for primary healthcare research in the Islands

with 14 documents and an H-index of 9. Paul F. George and Joan Llobera-Cánaves are the next most prolific authors, with eight publications each.

The geographical distribution of the top authors demonstrates a preponderance of research activity from the United States, Spain and New Zealand, indicating that primary healthcare research in island regions is of particular interest in these countries. In terms of research impact, Michael Stein D.M.D. and Jackson Rod had a notable influence, with 455 and 1848 total citations, respectively, despite their relatively lower number of publications (7 and 6 documents). This suggests that the number of publications may not be a reliable indicator of the impact of research in this field. The Author Frequency (AF) indicator demonstrates the diversity of collaboration patterns observed in island health research, reflecting the complexity and multidisciplinarity of this field. Christos D. Lionis exhibited the highest average number of authors per article (2.27), while Magdalena Esteva demonstrated the lowest average (0.53). The publication timeframe (PY Start) indicates that the majority of researchers have contributed to the field since the 1990s to early 2000s, with Armando J. Aguirre-Jaime representing a relatively recent addition (starting 2017).

## KEYWORD ANALYSIS

A visual representation of the research themes, generated using the VOSviewer software, revealed the existence of three dominant clusters within the field of primary healthcare in the islands, illustrated in Figure 4. Each group possesses distinctive yet interrelated characteristics and foci. Thematic analysis identified a dominant group (highlighted in red) that explored clinical dimensions and medical implementation. This cluster was distinguished by the use of particular terminology, including „human", „adult", „clinical practice", „primary care" and „controlled study" which collectively indicate a concentration on the pragmatic elements of healthcare. This cluster demonstrates a pronounced emphasis on clinical practice-based research, encompassing clinical trials, cross-sectional studies and investigations involving diverse age groups. The close relationship between the keywords in this cluster, indicated by the short connecting lines, demonstrates a robust integration within primary healthcare clinical research.

The green cluster pertains to aspects of health systems and services, as evidenced by the presence of keywords such as „healthcare delivery", „public health", „health services" and „community health services". This cluster demonstrates a pronounced emphasis on the organizational and managerial aspects of health services, particularly

in island regions, as evidenced by the presence of keywords such as „Caribbean Islands" and „Oceania". The pattern of relationships within this cluster indicates that research on healthcare systems in island regions considers a range of factors, including health policy, health facilities and public health services.

The blue cluster, although smaller in size, serves an important function as a connecting element between the red and green clusters, with keywords such as „healthcare personnel", „healthcare policy" and „public health service". The strategic positioning of this cluster illustrates the pivotal role of human resources and policy in integrating clinical aspects with the healthcare system. In the keyword mapping, the term „human" was identified as the central concept, as indicated by its largest visual representation. This illustrates the centrality of the human dimension in numerous studies on primary healthcare in island contexts, as evidenced by the high frequency of use of the term in various publications.

The node size-based analysis in the VOSviewer visualization demonstrated that the keyword „human" had the largest node located at the center of the network, followed by the keywords „healthcare delivery", „health services" and „primary care". The prominence of the „human" node size indicates that the human aspect is a central focus in primary healthcare research in the islands, with a high frequency of occurrence in the literature. Other prominent nodes, such as „healthcare delivery" and „primary care", indicate that research has also devoted considerable attention to these fundamental components of island health systems.

An examination of the strength of relationships between nodes, as indicated by the length and thickness of connecting lines, reveals an intriguing pattern. The presence of short and thick connecting lines between the keywords „human" and „healthcare delivery", „primary care" and „health services" indicates a robust relationship and high co-occurrence between these concepts in the literature. Furthermore, strong relationships were observed between „healthcare delivery" and „public health" and „community health services", indicating a close integration between the healthcare delivery system and public health aspects in the island context.

Furthermore, smaller nodes such as „rural healthcare", „manpower" and „health policy", despite having a lower frequency of occurrence, still demonstrate significant relationships with the main nodes through clear connecting lines. This indicates that these aspects, although not dominant, are still important considerations in island primary healthcare research. This pattern of relationships emphasizes the complexity and interconnectivity of the various aspects of the primary healthcare system in the Islands, where factors such as human resources, policy and rural access remain integral components of the research.

Furthermore, Figure 5 presents the temporal evolution of keywords in primary healthcare research in the islands, which is illustrated by the overlay visualization from VOSviewer. Keywords in yellow, which emerged around 1990–1995, are primarily concerned with clinical and methodological aspects, including „clinical trial", „controlled study", „primary care" and „cross-sectional study". This suggests that during the initial period, the emphasis was on methodological approaches and clinical studies in primary healthcare, with a particular focus on research design and evidence-based practice. This is in line with the findings of a research article published in the journal Health Services Research, which highlighted the importance of evidence-based approaches in primary healthcare [19].

The research developments shown in green (middle period) illustrate a shift in focus towards healthcare systems and organizations, with the emergence of keywords such as „healthcare delivery", „public health" and „community health services". This transition reflects the evolution of research from an individualized clinical approach to a more systemic and community-oriented perspective. This period was also marked by the emergence of attention to aspects of health policy and health services management, indicating a growing understanding of the complexity of health systems in island regions. In a 2000 study published in the British Medical Journal, Campbell and colleagues identified the significance of community integration in the development of primary health systems in rural and island settings [20]. This finding was corroborated by a 2003 systematic review conducted by Haggerty and colleagues in the journal Medical Care, which revealed that maintaining continuity of healthcare represents a significant challenge in island contexts, particularly concerning accessibility and distribution of health resources [21].

Keywords that appear in the more recent period (shown in blue to purple, around 2005–2010) illustrate a focus on demographic aspects and regional development. This is evidenced by the appearance of keywords such as „developing country", „demographic factors", „population dynamics" and „maternal-child health services". This pattern indicates a shift in research towards a more comprehensive understanding of the social determinants of health and the specific needs of populations in island regions, particularly in relation to maternal and child health and demographic factors that influence regional development. A comprehensive study published in The Lancet examined the impact of demographic and socioeconomic factors on the integration of primary healthcare programs in developing countries, including those in the Islands [22]. These findings were

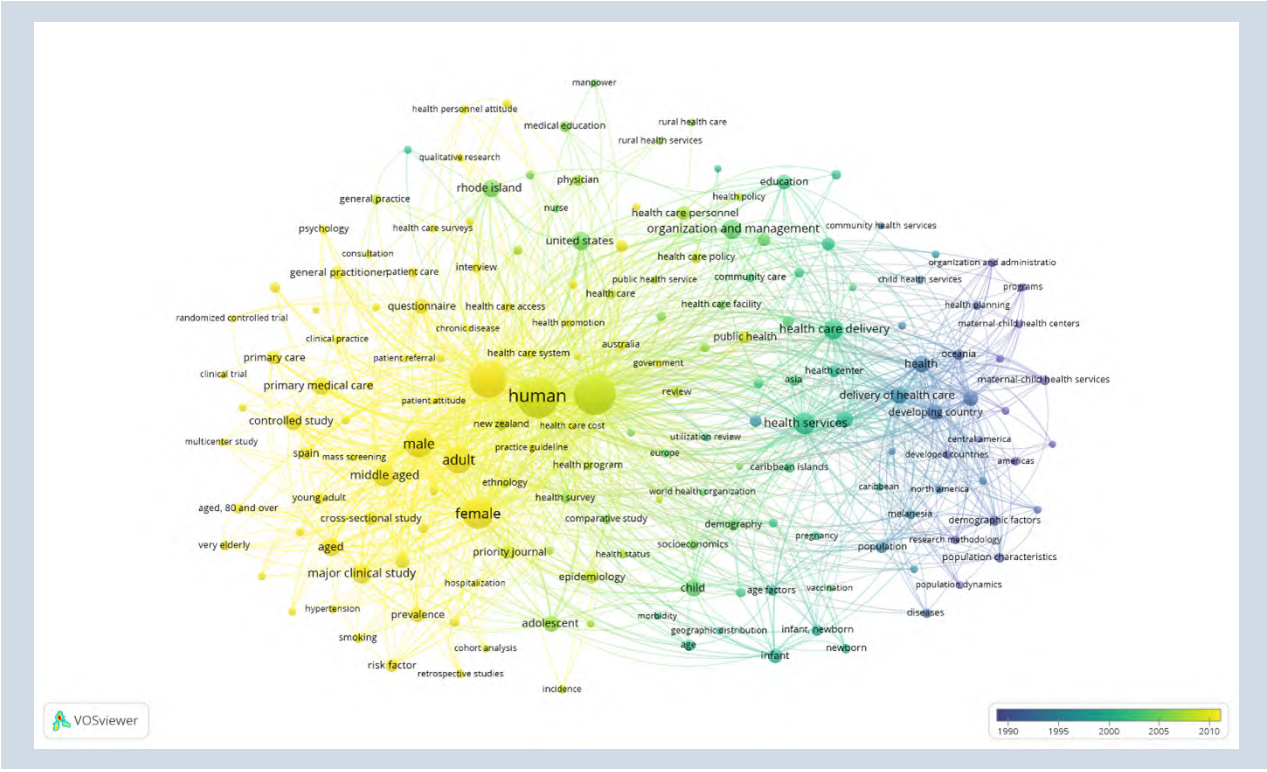


**Figure 5.** Visualization of temporal overlays of primary healthcare research keywords in island regions

corroborated by a study in the journal Health Policy that investigated the relationship between population characteristics and patterns of primary healthcare in diverse geographic settings, including islands [23].

## PREDICTION OF FUTURE RESEARCH DIRECTIONS

A review of the network patterns and temporal evolution of keywords offers insights into the potential future directions of research development in the field of primary healthcare in the islands. Based on this analysis, several potential future research directions can be predicted. First, there is potential for the development of research that integrates digital technology in primary healthcare in the islands, given the limited number of nodes that currently address the technological aspects of visualization. This is significant given the strategic position of the keywords „healthcare delivery" and „health services", which have strong connectivity with various aspects of health services. The integration of digital technologies such as telemedicine and health information systems could serve as a solution to overcome geographical challenges and limited access in the islands [9].

The temporal trends observed in the overlay visualization also indicate that future research will increasingly adopt a more holistic, population-based approach. This is evident from the proliferation of keywords related to demographics and maternal-child health in the recent period (shown in blue-purple). It may be reasonably inferred that future research will investigate the integration of primary healthcare with the social determinants of health, particularly in the context of climate change and island health resilience. Furthermore, the paucity of nodes addressing sustainability and resilience in health systems suggests that this domain offers significant scope for future research, particularly in light of the heightened vulnerability of island regions to environmental and socio-economic shifts [24].

A methodological review of the interconnections between key concepts revealed new insights into the potential for cross-disciplinary studies. This pattern suggests opportunities for the development of more comprehensive and integrated research approaches in island health studies. The strength of the relationship between clinical clusters (yellow) and health systems clusters (green) shown in the network visualization indicates opportunities for research development that combines clinical aspects with health systems and policy approaches. In the future, it is predicted that more studies will employ mixed methods and participatory research approaches to gain a more

comprehensive understanding of the complexity of primary healthcare in islands.

## CONCLUSIONS

The results of this bibliometric analysis indicate a significant growth in research on primary healthcare in the islands between 1972 and 2024, with 724 articles published across 384 journals at an annual growth rate of 6.03%. The United States, Spain and Australia were the top contributors, with leading institutions including the University of Auckland, the University of Crete and the University of Otago. Key journals were Medicine and Health and The International Journal of Environmental Research and Public Health. Keyword analysis identified three main themes: clinical implementation, health systems and policy-human resources. Over time, the research focus shifted from clinical methods (1990s) to systemic, community-based approaches (2000s) and demographic-regional development (2005–2010). Furthermore, this review identifies key future research directions for primary healthcare in island settings, emphasizing the integration of digital technology, holistic approaches and interdisciplinary studies. There is significant potential to explore telemedicine and health information systems to address geographical challenges and enhance access, as highlighted by the strong connectivity of keywords like „healthcare delivery" and „health services". Temporal trends reveal an increasing focus on demographics, maternal-child health and social determinants of health, particularly in the context of climate change and island health resilience. The limited attention to health system sustainability and resilience underscores opportunities for research addressing the vulnerability of island regions to environmental and socio-economic changes. Network analyses suggest the potential for integrated studies that combine clinical, policy and health systems perspectives, while methodological advancements are anticipated through mixed methods and participatory approaches to better address the complexity of primary healthcare in these settings. These findings provide a foundation for developing evidence-based policies to enhance health services in island regions.

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# Intestinal parasitic infections among BaAka Pygmies and Bantu people living in the rain forests in Lobaye Prefecture, Central African Republic

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## ABSTRACT

***Background:*** *Central African Republic (CAR) is one of the poorest countries in the world with nearly 65% of its inhabitants living in extreme poverty, and 87% lacking access to safely managed sanitation facilities. Poor sanitation and limited access to healthcare contribute to high transmission of intestinal parasitoses. The present study aimed to assess the occurrence of intestinal parasitic infections (IPIs) in two separate ethnic groups inhabiting the rainforests in the Lobaye Prefecture in the southern parts of the CAR: the nomadic BaAka Pygmies and the sedentary Bantu people. In addition, the results obtained from the examination of the Pygmy people were compared to the results of the 2021 study on the occurrence of IPIs in a Pygmy community inhabiting the Sangha-Mbaéré Prefecture in the CAR, in the context of the effectiveness of mass deworming actions among the population living in the forest ecosystem.*

***Materials and methods:*** *Stool samples for parasitological examination were collected from 170 patients (145 Bantu people and 25 BaAka Pygmies) in September 2024 at a healthcare facility in Bagandou, the Lobaye Prefecture, CAR. The exclusion criterion was taking antiparasitic drugs within four weeks before collecting the biological material for testing. The collected biological material was fixed in SAF fixative, and next it was transported to the Department of Epidemiology and Tropical Medicine at the Military Institute of Medicine – the National Research Institute in Poland, where it was examined by light microscopy; the specimens were prepared for examination using three different methods (a direct smear in Lugol's solution, decantation with distilled water, the Fülleborn's flotation method).*

***Results:*** *A total of 38.2% of the study participants were found to be infected with at least one clinically significant parasitic species. Apart from potentially pathogenic Blastocystis spp. and non-pathogenic protozoa, hookworm, Giardia intestinalis and Ascaris lumbricoides were found to be the most prevalent parasitic species in the study participants. More than 60% of the participants were found to be co-infected with at least two different parasitic species. The occurrence of IPIs was significantly higher in BaAka Pygmies compared to the sedentary Bantu people. It also demonstrated that the infection rate was lower in older age groups.*

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***Conclusions:*** *The study demonstrated a high occurrence of intestinal parasitic infections both among BaAka Pygmies and in the Bantu people inhabiting the Lobaye Prefecture. Mass deworming campaigns conducted by catholic missionaries, as well as non-governmental organisations, are not effective in reducing the number of STH cases in the local communities. Continuous exposure to risk factors and the unique lifestyle of the local residents put them at risk of permanent reinfections.*

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**Keywords: intestinal parasites, epidemiology, deworming, Pygmies, Bantu, CAR**

## INTRODUCTION

Intestinal parasitic infections (IPIs) are a major epidemiological challenge in many tropical countries. The major risk factors contributing to the spread of IPIs include poor sanitation and hygiene practices, a lack of access to healthcare, a low level of education and poverty [1]. The World Health Organisation (WHO) has estimated that over 1.5 billion people globally are infected with IPIs, mostly in Africa and Asia [2]. African countries dominate the list of the poorest states in the world; in fact, more than 80% of the world's poorest countries are located in Africa [3], with the Central African Republic (CAR) also on the list. According to the World Bank estimates, more than 65% of this country's residents live in extreme poverty (on less than USD 2.15 a day), and only 13% have access to safely managed sanitation facilities. The education index in the CAR is one of the lowest in the world, with the expected years of schooling of only 4.5 years on average (in fact, the expected years of schooling for girls is 1.5 years shorter due to significant gender inequalities in the country). It has been estimated that around half of the country's population requires humanitarian aid. In addition, the prevalence of maternal mortality, under-five mortality and malnutrition remain exceptionally high in the CAR [4, 5]. The country's population consists of many ethnic groups, including the BaAka Pygmies – semi-nomadic hunter-gatherers who reside in the rainforests in the southern parts of the CAR [6]. Due to their low socioeconomic status, Pygmy tribes have limited access to agricultural land and safe water sources, which makes their lives extremely difficult. Moreover, limited access to healthcare and a lack of even the most basic knowledge on proper hygiene practices make them extremely susceptible to infections transmitted via the oral-faecal route, such as IPIs [7, 8].

IPIs, and especially soil-transmitted helminths (STHs), remain a major public health threat in many tropical countries. This is predominantly attributable to the lack of epidemiological surveillance in many lower-income countries, a lack of health education on infectious risk factors and disease prevention methods, as well as critical shortages of diagnostic and healthcare facilities. If IPI cases are left untreated, they can progress into a chronic form, which is often accompanied by a malabsorption syndrome eventually leading to malnutrition and anaemia. The latter two have a negative impact on the affected patients' immune systems as well as their cognitive abilities and eventually their productivity. Long-term effects of IPIs often lead to marginalization and socio-economic exclusion of the affected individuals, and have a very negative impact on the lives of individual families as well as whole communities [3, 9]. The WHO has undertaken steps to combat the transmission of IPIs in endemic areas by initiating and supporting mass drug administration programs. The organization recommends periodic deworming with a single dose of albendazole (400 mg) or mebendazole (500 mg). Preventive chemoprophylaxis of IPIs which is delivered to high-risk populations is essential for limiting or possibly eradicating infections caused by intestinal parasites, especially in asymptomatic carriers. However, periodic deworming itself is not likely to bring lasting effects in highly endemic settings without improving sanitary conditions and promoting health education in the region [10, 11]. The present study aimed to assess the occurrence of intestinal parasitic infections (IPIs) in individuals recruited from among two ethnic groups inhabiting the rainforests in the Lobaye Prefecture in the south of the CAR: the nomadic BaAka Pygmies and the sedentary Bantu. In addition, the occurrence of IPIs in Pygmies was compared to the results of the 2021 screening study which involved a group of the Pygmies residing in the Sangha-Mbaéré Prefecture in CAR, in the context of the effectiveness of mass deworming actions among the population living in the forest ecosystem.

## MATERIALS AND METHODS

### STUDY POPULATION

The biological material for parasitological examinations (stool samples) was obtained in September 2024. The study group consisted of 170 participants recruited from among two ethnic groups living in the rainforest in the Lobaye Prefecture in the CAR (Fig. 1): BaAka Pygmies (n = 25) and Bantu (n = 145). The Bantu are a sedentary tribe, who mainly live off farming and animal husbandry, whereas BaAka Pygmies are a group of semi-nomadic, hunter-gatherers with limited access to agricultural land [10]. The study


**Figure 1.** A map of Africa with the location of Bagandou, the Lobaye Prefecture, Central African Republic

participants were recruited from among the individuals who voluntarily reported to a healthcare facility operating on the premises of a catholic mission in Bagandou. Each resident of the Lobaye Prefecture could participate in the study, as there were no limitations concerning the age, sex or ethnic origin of the participants. The exclusion criterion was taking antiparasitic drugs within four weeks before collecting the biological material for testing. Due to a high rate of illiteracy in the region, all necessary explanations and information on the study purpose and its methodology were provided to the participants orally by medical personnel employed at the Bagandou healthcare centre before the commencement of the study. All participants were required to provide informed consent to participate in the study. The mean age of the study participants was 25.9 years (age range 1–75 years; 59.1% children < 15 years old, including 22.3% children ≤ 5 years old). The male-to-female ratio was 0.5.

## SAMPLE COLLECTION AND LABORATORY PROCEDURES

The material for parasitological examinations consisted of self-collected single stool samples. Each of the study participants was provided with a stool sample collection kit and was asked to half-fill the stool sample container with a sample of their faeces and to deliver it the healthcare centre in Bagandou on the day of collection. Once the sample had been delivered to the healthcare facility, the material was fixed in SAF fixative (sodium, acetate-acetic, acid-formalin, distilled water), and next it was transported to the Department of Epidemiology and Tropical Medicine of the Military Institute of Medicine — National Research Institute in Gdynia, Poland, where laboratory examinations by light microscopy were performed 3 weeks after collection. Each sample was examined three times using three different diagnostic methods (direct smear in Lugol's solution, decantation with distilled water, the Fülleborn's flotation [12]. When *Entamoeba histolytica/dispar* parasites were identified by microscopic methods, molecular tests were used to differentiate between the two species. For this purpose, approximately 100 mg of a stool sample was put in a 2 ml test tube. The sample was then rinsed three times with distilled water to remove the SAF fixative. The extraction process was then carried out using a commercial Genomic Mini AX Stool DNA isolation kit (A&A Biotechnology, Poland) in line with the manufacturer's instructions. The obtained eluate was treated with an anti-inhibitor provided by the manufacturer (A&A Biotechnology, Poland) and next it was subjected real-time PCR procedure to differentiate between the species using a commercial kit manufactured by AmpliTest *Entamoeba histolytica* (Amplicon, Poland).

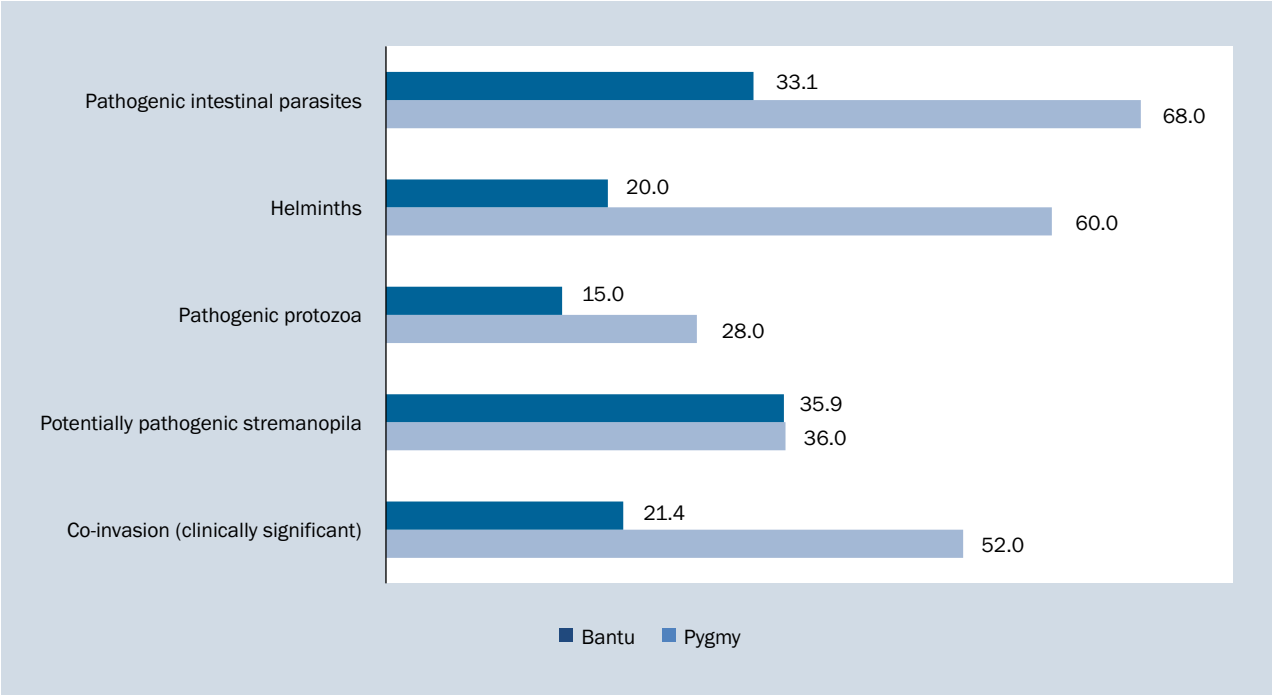


**Figure 2.** Distribution of intestinal parasites [%] in Bantu (n = 145) and BaAka Pygmies (n = 25)

The results were interpreted in line with the manufacturer's recommendations (a fluorescence increase with a Cq value ≤ 40 in the FAM channel indicated the presence of *E. histolytica*, while a fluorescence increase with a Cq value ≤ 40 in Texas Red indicated the presence of *E. dispar*).

## STATISTICAL ANALYSIS

All statistical calculations were performed using the data analysis software *Statistica* (version 13, TIBCO Software Inc., Palo Alto, California, the USA, 2017) accessed on the website https://www.statsoft.pl on 02 December 2024 and the Microsoft Excel spreadsheet programme. The Chi-squared test was used to determine the relationships between variables. In all calculations, the level of statistical significance was set at p = 0.05.

## ETHICAL APPROVAL

The research project was approved by the Committee on Bioethics at the Military Institute of Medicine, Warsaw, Poland (Decision No. 138/WIM/2018 of 19 December 2018).

## STUDY VARIABLES

The authors analysed the correlation between the occurrence of IPIs and the ethnic origin, sex and age of the study participants. In addition, the results of the present study (more specifically, the occurrence of IPIs in Pygmies) were compared to the results of the 2021 screening study which involved a group of Pygmies residing in the Sangha-Mbaéré Prefecture, CAR.

## RESULTS

The microscopic examinations of stool samples collected from 170 residents of the Lobaye Prefecture demonstrated that 65 of the study participants (38.2%) were infected with at least one intestinal parasite. A large number of the participants were also carriers of stramenopila *Blastocystis* spp. (35.9%) and of non-pathogenic protozoa: *Entamoeba coli, Entamoeba hartmanii, Entamoeba dispar, Endolimax nana, Iodamoeba bütschlii, Chilomastix mesnili* (37.1%). Most of the clinically significant infections were either helminthiases, such as hookworm infections (20.0%) or ascariasis (8.2%), or protozoan infections including giardiasis (17.1%). Also, a high prevalence of co-infections (42.2%) was found, of which over 60% were caused by at least one clinically important parasitic species. No statistically significant difference was found regarding the occurrence of clinically significant infections between women and men (p value = 0.4609). However, it was observed that the carriage of non-pathogenic protozoa (mainly *Entamoeba* spp. and *Endolimax nana*; p value = 0.0062) was higher in women. These findings were similar in both ethnic groups studied. Interestingly, significant differences were observed regarding the occurrence of IPIs between BaAka Pygmies and Bantu (p value = 0.0009). The occurrence of infections caused by pathogenic intestinal parasites was 2-fold higher, and the occurrence of helminthic infections was 3-fold higher among semi-nomadic Pygmies compared to Bantu people, which is shown in Figure 2 and Table 1.

**Table 1.** Distribution of intestinal parasites detected in the group of BaAka Pygmies (n = 25) and Bantu (n = 145)

| | **Total** | | | **p value** | **Pygmy** | | | **p value** | **Bantu** | | | **p value** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **n = 170 (%)** | **F [n = 113] (%)** | **M [n = 57] (%)** | | **n = 25 (%)** | **F [n = 17] (%)** | **M [n = 8] (%)** | | **n = 145 (%)** | **F [n = 96] (%)** | **M [n = 49] (%)** | |
| Positive results (with *Blastocystis* spp. and non-pathogenic protozoa) | 250 (100.0) | 182 (72.8) | 68 (27.2) | 0.1075 | 61 (24.4) | 43 (70.5) | 18 (29.5) | 0.3998 | 189 (75.6) | 139 (73.5) | 50 (26.5) | < 0.05 |
| **Positive results of pathogenic intestinal parasites** | **81 (32.4)** | **54 (29.7)** | **27 (39.7)** | 0.4609 | **28 (45.9)** | **19 (44.2)** | **9 (50.0)** | 0.6068 | **53 (28.0)** | **35 (25.2)** | **18 (36.0)** | 0.1671 |
| **Helminths** | **51 (20.4)** | **34 (18.7)** | **17 (25.0)** | 0.6437 | **21 (34.4)** | **14 (32.6)** | **7 (38.9)** | 0.8611 | **30 (15.9)** | **20 (14.4)** | **10 (20.0)** | 0.5984 |
| *Ancylostoma duodenale/ Necator americanus* | 34 (66.7) | 21 (61.8) | 13 (76.5) | | 15 (71.4) | 9 (64.3) | 6 (85.7) | | 19 (63.3) | 12 (60.0) | 7 (70.0) | |
| Ascaris lumbricoides | 14 (27.5) | 11 (32.4) | 3 (17.6) | | 5 (23.8) | 4 (28.6) | 1 (14.3) | | 9 (30.0) | 7 (35.0) | 2 (20.0) | |
| Dicrocelium dendriticum | 1 (2.0) | 1 (2.9) | 0 (0.0) | | 1 (4.8) | 1 (7.1) | 0 (0.0) | | 0 (0.0) | 0 (0.0) | 0 (0.0) | |
| Trichuris trichiura | 1 (2.0) | 0 (0.0) | 1 (5.9) | | 0 (0.0) | 0 (0.0) | 0 (0.0) | | 1 (3.3) | 0 (0.0) | 1 (10.0) | |
| Hymenolepis nana | 1 (2.0) | 1 (2.9) | 0 (0.0) | | 0 (0.0) | 0 (0.0) | 0 (0.0) | | 1 (3.3) | 1 (5.0) | 0 (0.0) | |
| **Pathogenic protozoa** | **30 (12.0)** | **20 (11.0)** | **10 (14.7)** | 0.9800 | **7 (11.5)** | **5 (11.6)** | **2 (11.1)** | 0.8188 | **23 (12.2)** | **15 (10.8)** | **8 (16.0)** | 0.9129 |
| Giardia intestinalis | 29 (96.7) | 19 (95.0) | 10 (100.0) | | 7 (100.0) | 5 (100.0) | 2 (100.0) | | 22 (95.7) | 14 (93.3) | 8 (100.0) | |
| Entamoeba histolytica | 1 (3.3) | 1 (5.0) | 0 (0.0) | | 0 (0.0) | 0 (0.0) | 0 (0.0) | | 1 (4.3) | 1 (6.7) | 0 (0.0) | |
| **Stramenopila** | **62 (24.8)** | **47 (25.8)** | **15 (22.1)** | 0.0648 | **10 (16.4)** | **7 (16.3)** | **3 (16.7)** | 0.9146 | **52 (27.5)** | **40 (28.8)** | **12 (24.0)** | 0.7369 |
| *Blastocystis* spp. | 62 (100.0) | 47 (100.0) | 15 (100.0) | | 10 (100.0) | 7 (100.0) | 3 (100.0) | | 52 (100.0) | 40 (100.0) | 12 (100) | |
| **Non-pathogenic protozoa** | **107 (42.8)** | **81 (44.5)** | **26 (38.2)** | 0.0062 | **23 (37.7)** | **17 (39.5)** | **6 (33.3)** | 0.2011 | **84 (44.4)** | **64 (46.0)** | **20 (40.0)** | 0.0149 |
| Co-invasion (with non-pathogenic protozoa) | 72 (42.4) | 52 (46.0) | 20 (35.1) | | 15 (60.0) | 11 (64.7) | 4 (50.0) | | 57 (39.3) | 41 (42.7) | 16 (33.0) | |
| **Pathogenic co-invasions** | **44 (25.9)** | **31 (27.4)** | **13 (22.8)** | 0.5156 | **13 (52.0)** | **9 (52.9)** | **4 (50.0)** | 0.8908 | **31 (21.4)** | **22 (22.9)** | **9 (18.0)** | 0.5274 |

F – female; M – male

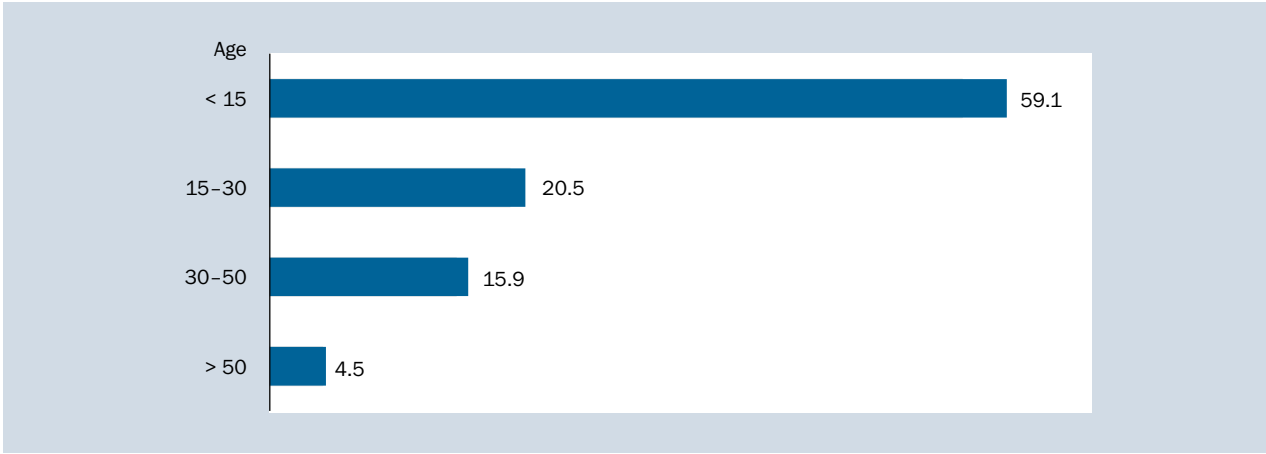


**Figure 3.** Distribution of intestinal parasites [%] in the study group by age (n = 170)

**Table 2.** Distribution of soil-transmitted helminths detected in BaAka Pygmies in 2021 (n = 49) and in 2024 (n = 25)

| Helminths | Percentage of infected Pygmies | | p value |
|---|---|---|---|
| | 2021 (n = 49) | 2024 (n = 25) | |
| STHs | 62.1 | 60.0 | < 0.0001 |
| *Ancylostoma duodenale/ Necator americanus* | 34.7 | 52.0 | < 0.0001 |
| *Ascaris lumbricoides* | 28.6 | 20.0 | < 0.0001 |
| *Trichuris trichiura* | 8.2 | 0.0 | 0.0008 |
| *Trichostrongylus spp.* | 8.2 | 0.0 | 0.0159 |
| *Dicrocelium dendriticum* | 0.0 | 4.0 | 0.1532 |

**STHs — soil-transmitted helminths**

Most IPIs were seen in the paediatric population, with the prevalence of IPIs decreasing with age, which is shown in Figure 3. Interestingly, the opposite was the case concerning infections caused by non-pathogenic or potentially pathogenic parasites — the number of these invasions was observed to increase with age.

Table 2 compares the distribution of soil-transmitted helminths in the BaAka Pygmies inhabiting the Sangha-Mbaéré Prefecture (a study of 2021; adult patients aged 17–57 years) and the Lobaye Prefecture (the 2024 study; patients aged 1–60 years; 48.0% children < 15 years old, including 32.0% children ≤ 5 years old). Both studies were based on the same methodology, i.e. parasitological examination of stool samples by light microscopy, and both were performed at the Department of Epidemiology and Tropical Medicine of the Military Institute of Medicine — National Research Institute in Poland.

The results show a high overall occurrence of STHs in BaAka Pygmies, especially hookworm infections and ascariasis. The findings suggest that periodic deworming carried out free of charge once a year among all adults and children over 2 years of age (who are under the care of health centres in Catholic mission areas) does not affect reducing the occurrence of STH infections.

## DISCUSSION

IPIs are unevenly distributed in the world. The occurrence of infections caused by intestinal parasites is strongly correlated with tropical and subtropical climate conditions, poor sanitation, overcrowding, poor knowledge of hygiene practices (both personal hygiene as well as food hygiene), and limited access to safe drinking water and healthcare. A majority of IPIs are reported from African and Asian countries [3], e.g. from the Central African Republic (CAR), which is a country lying in Sub-Saharan Africa. The literature data on the prevalence of IPIs in Central Africa are inconsistent, with significant discrepancies between individual studies resulting from differences in their

set-up and sample characteristics (setting, age and demographic variables of participants, presence/absence of comorbidities). As an example, the prevalence of STHs in Cameroon, a country bordering the CAR to the west, ranges between 4.2 and 66.8% between different studies [14–18]. A study conducted by Irisarri-Gutiérrez et al. [19] on a sample of 674 children living in Rwanda showed that 95.3% of the study participants had IPIs, of whom 36.1% were infected with geohelminths. Another study which was conducted in the Democratic Republic of the Congo, a country bordering the CAR to the south, also confirmed a high prevalence of STHs in local children (73.8%) [20]. In contrast, the prevalence of STHs in Chad and Gabon (two other Central African countries) was found to be only 16.5% [21] and 12% [22], respectively. The overall prevalence of IPIs was found to be as follows: 29.9% in Gabon [22], 64.7% in São Tomé and Príncipe [23] and 55% in Angola [24]. It needs to be stressed, however, that most of these studies focused on the paediatric populations only, which are not representative of the general population because of their higher vulnerability to parasitic infections resulting from children's underdeveloped immune systems and poor hygiene habits [25]. The results of the present study showed that 69.4% of the study participants were infected with intestinal parasites, which is consistent with the results of the studies carried out in Cameroon and São Tomé and Príncipe. The overall occurrence of STHs in the present study was found to be 25.9% (which is higher than in Gabon or Chad), and it was the highest in the paediatric age group, which is consistent with the data reported from Rwanda. The data on the distribution of IPIs in the CAR are scarce and mostly out-of-date. A large-scale study involving 3000 residents of Bangui, the capital of the CAR, which was conducted in the 1980s demonstrated that 46.8% of the study participants were infected with at least one intestinal parasitic species, with hookworm infections being predominant. Interestingly, the results of the study seem to be consistent with the latest reports [26]. Two independent studies were conducted in the southern parts of the CAR nearly a decade ago. One of these studies involved a group of local children living in rural areas [27], while the other study examined a group of BaAka Pygmies inhabiting the rainforest of the Congo Basin [10]. Both studies showed high rates of parasitic infections (88.2–90.5%), with *Ascaris lumbricoides* and hookworm infections being predominant. The predominance of these two species over other STHs was also observed in a study carried out in 2021 which involved a sample of 49 BaAka Pygmies living in the Sangha-Mbaéré Prefecture in the southern part of the CAR [10]. All four studies cited above reported a high prevalence of co-infections [10, 13, 26, 27]. In terms of the qualitative analysis, the results of the authors' study conducted in 2024 are consistent with the findings by other authors and confirm the predominance of hookworm and *Ascaris lumbricoides* infections among the CAR's residents. The results obtained by the authors of the present study also confirm a high rate of polyparasitism in the population studied. The global prevalence of polyparasitism is not known, however, high rates of co-infections with different parasitic species in some populations are considered to affect clinically significant morbidity rates and may also increase susceptibility to other infections or parasitic invasions as well as exacerbate the clinical picture of pre-existing illnesses, such as AIDS or tuberculosis [28].

The predominance of hookworm infections in the study group is attributable to lifestyle-related risk factors, such as working outdoors, having contact with potentially contaminated soil or walking barefoot i.e. the risk factors which are particularly common in rural areas [28, 29]. The present study found no significant correlation between sex and the rates of invasions caused by pathogenic parasites, which is in line with the findings of other authors [28, 30]. Yet, a correlation was found between the prevalence of parasitic invasions and the age of the study participants, with the prevalence of clinically significant parasitic infections being higher in the age group 0–15 years. This finding is not surprising because children are at a higher risk of transmission compared to adults [25].

The exceptionally high prevalence of parasitic infections in Central Africa has prompted the WHO to introduce large-scale periodic deworming programs in the region [31]. Studies have shown that periodic mass drug administration (MDA) consisting of the annual administration of antiparasitic agents to the entire population has proved to be effective in reducing STH transmission [32–35]. The major benefits of MDAs include their relatively low cost and improvement in the haematological parameters, but also a significant improvement of the patients' general health including their well-being and physical fitness [36, 37]. Such positive effects of mass anti-parasitic treatment were observed among employees of food processing and catering plants at the multinational military base UCATEX in Bangui [35], but also among the BaAka Pygmies inhabiting the Sangha-Mbaéré Prefecture [13]. However, despite a reduction in the number of STH infections (when compared to previous years), the results of MDA campaigns are not fully satisfactory. The parasitic species which were found to be predominant in this study are either transmitted via the oral-faecal route (the ingestion of food or water contaminated by parasites at various developmental stages) or via direct contact with contaminated soil (e.g. while walking barefoot) [38]. The results suggesting no effect of periodic deworming on the reduction of intestinal parasitic infections may be due to the insufficient frequency of antiparasitic drug administration. In

regions with very high endemicity (such as in southern CAR), reinfection may occur shortly after treatment, making single or infrequent interventions less effective. The WHO recommends two doses per year in such populations, especially in high-risk groups [39]. Unfortunately, in the study area, poverty and poor health infrastructure limit the possibility of regular interventions, and deworming activities are often carried out by NGOs and humanitarian missions. Furthermore, without improved sanitation and access to clean water, the effect of deworming remains short-lived, which may explain the lack of long-term impact observed in this study. Therefore, to significantly reduce the prevalence of IPIs in southern parts of the CAR, it is crucial to promote good hygiene practices among local residents, such as washing food before eating it or wearing footwear while being outdoors. Although the ultimate goal of MDAs is to completely eradicate STHs in high-risk countries, this goal might be difficult to achieve without implementing additional preventive measures [40]. As an example, a significant reduction in the prevalence of soil-transmitted helminthiases in South Korea was possible thanks to the introduction of nationwide epidemiological surveillance and periodic administration of targeted chemotherapy to entire communities. In fact, the prevalence of STHs in the country dropped from 84% to only 2.4% between the 1970s and 1990s [41].

The present study involved a group of individuals residing in the southern parts of the CAR who voluntarily participate in mass deworming programs consisting of the annual administration of a single dose of albendazole (400 mg). The same applied to patients studied in 2021 [13]. The results of the present study as well as the results of the previous study conducted in 2021 demonstrated a high IPI occurrence. The unique lifestyle of the people involved in the study, especially of the nomadic Pygmy people, puts them at risk of permanent reinfections. The lack of improvement in sanitation and hygiene practices as well as the lack of education on common health risk factors and disease prevention methods contribute to increased exposure to IPIs and multiple re-invasions. Thus, periodic deworming which is recommended by WHO may be insufficient to effectively control IPI transmission and the disease burden both among the sedentary Bantu people and the nomadic BaAka Pygmies. Therefore, apart from conducting MDAs, it is crucial to raise health awareness among the local people and to provide them with easy access to healthcare and diagnostic facilities.

## CONCLUSIONS

The study found a high occurrence of intestinal parasitic infections both among BaAka Pygmies and Bantu people inhabiting the Lobaye Prefecture. Mass deworming campaigns conducted by catholic missions as well as non-governmental organisations are not effective in reducing the number of STH cases in local communities. Permanent exposure to risk factors as well as the unique lifestyle of local residents put them at risk of multiple reinfections. The WHO-recommended MDA campaigns alone may not be sufficient to completely eradicate IPIs from endemic countries. The risk factors contributing to multiple re-invasions include poor sanitation and bad hygiene practices, a lack of basic health education, direct contact with contaminated soil while working outdoors, but also a common practice of walking barefoot.

## ARTICLE INFORMATION AND DECLARATIONS

**Data availability statement:** The authors confirm that the data supporting the findings of this study are available within the article.

**Ethics statement:** The research project was approved by the Committee on Bioethics at the Military Institute of Medicine, Warsaw, Poland (Decision No. 138/WIM/2018 of 19 December 2018).

**Author contributions:** Monika Pintal-Ślimak — collecting biological material for diagnostics; Wanesa Wilczyńska — preparation of the project and typescript, diagnostics; Konrad Grzeszczak — selection of the data; Marta Grubman-Nowak – selection of the data; Krzysztof Korzeniewski — review and editing, preparation of the final version of the manuscript. Authors have read and agreed to the published version of the manuscript.

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# Assessing the clinical management and outcomes of venomous marine animal injuries in Turkey

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## ABSTRACT

***Background and objectives:*** *SCUBA diving is a widely popular activity in Turkey, surrounded by seas on three sides. While most marine creatures in these waters are harmless, a few poses significant risks, necessitating awareness and precautions for divers' safety. This report highlights the various harmful sea creatures found in Turkish waters, their potential injuries, and appropriate first aid responses.*

***Materials and methods:*** *Data were gathered from workshops, literature reviews, diving activities and case reports.*

***Results:*** *Notable harmful species include jellyfish, sea anemones, bristle worms, sea urchins, greater weever fish, and others. Injuries range from stings and bites to venom-induced symptoms, requiring immediate and specific medical interventions.*

***Conclusions:*** *The paper aims to enhance the recognition and management of harmful marine life encounters in Turkish waters, especially among emergency doctors and general practitioners.*

*(Int Marit Health 2025; 76, 2: 136–143)*

**Keywords: sea creatures, extreme environments, poisonous animals, venomous marine animals**

## INTRODUCTION

One of the commonly used methods in professional or recreational diving is SCUBA diving, and the term consists of the initials of the English definition "Self-Contained Underwater Breathing Apparatus". Today, SCUBA is widely used as a general term [1–3]. SCUBA diving involves the use of a portable air source that allows the diver to remain submerged independently of the surface for a period of time [4, 5]. Before the nineteenth century, with limited transportation facilities, oceans were viewed by western society as merely a waterway between continents, and the sea was seen as a large space that was thought to be completely empty and devoid of any features [6]. With the developments in technology and the design of diving suits that provide protection against cold in the twentieth century, many negative effects of diving have become manageable [7, 8].

Recreational SCUBA diving stands out as a popular form of ecotourism today, along with social trends in travel and tourism [9, 10]. Recreational diving is a type of diving that encompasses skills related to a variety of adventure, leisure, and recreational activities and is distinct from commercial, military, public safety or scientific diving. The increasing demand for SCUBA diving as a recreational-adventure activity has also led to an increasing interest in leisure activities that take place in natural underwater environments, as well as in fauna and flora habitats, artificial and natural reef formations, various geological formations, close to the local ecosystem [11, 12].

In addition, as popular culture increased interest in recreational SCUBA diving, television documentaries, films and books of leaders such as Hans and Lotte Haas and Jacques-Yves Cousteau attracted diving enthusiasts

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**Figure 1.** Moon Jellyfish (*Aurelia aurita*)

[13]. Diving has become a much more common activity today.

Turkey consists of a peninsula surrounded by sea on three sides. Although most of the creatures living in our seas are harmless to humans, a limited number of them can cause some problems. Although all safety precautions are taken during diving, it would be beneficial for divers to recognize and avoid contact with harmful sea creatures for their own health and safety.

Harmful marine creatures can cause traumatic injuries or poisoning with their toxins. Many marine creatures are equipped with poison systems for defensive or hunting purposes. We aimed to point out the marine creatures in our country's seas that are not well known and that may cause injuries to divers and fishermen, and the species that come from tropical seas and continue to live in our seas, and to emphasize the precautions that should be taken in case of injury with these creatures.

## MATERIALS AND METHODS

For this compilation, the Workshop on Harmful Marine Creatures in Turkish Seas was held at the Bodrum Chamber of Commerce on May 5, 2014, and all topics were carefully evaluated and various articles and writings about the creatures were examined and compiled in detail [14].

DAN Europe (Divers Alert Network Europe, European Diving Safety Foundation) is a non-profit international medical and research organization dedicated to the health and safety of SCUBA divers. These issues are discussed in detailed in the book "DAN First Aid for Harmful Marine Life Injuries", which was first published in January 2000 and its last edition was December 2017 [15]. Harmful sea creatures: They were examined separately under headings such as those that affect health with their poisons, those that cause traumatic wounds by biting, and those that cause poisoning due to eating seafood. Points to be taken into consideration to prevent injury from harmful marine creatures are stated. It was emphasized that basic life support should be given first in case of injury, and the first aid and advanced aid that should be given according to each different type of injury were specified. DAN also has a certificate program for divers on "First Aid for Harmful Marine Creatures and Injuries".

Harmful sea creatures are also mentioned in a separate section in the latest edition of the United States Navy Diving Manual (USN Diving Manual), which contains the most accepted and valid information about today's underwater diving activities [16].

Information obtained from all these sources and case reports of harmful marine creatures recorded in Turkish waters were discussed [31, 35, 40, 41].

## RESULTS

The most common jellyfish in Turkey waters is the Moon jellyfish (*Aurelia aurita*, Fig. 1). This species, which is a relatively non-poisonous jellyfish, is usually seen in polluted areas of the seas and on the coasts. Rarely, they can also be found in brackish waters. Burning capsules called nematocysts are located on their outer surfaces called tentacles, and they cause burning and redness on contact [17]. Washing the contact skin with heated sea water will reduce these effects. Freshwater should never be used. It is extremely important for the injured person to be calm and still to prevent the blood flow rate from increasing. Sticky tentacles should be removed. Depending on the situation, cold compresses should be applied to the affected area. If no benefit is achieved, it should be immersed in 42–45°C water for 30 minutes or until the pain subsides. If the onset of systemic symptoms cannot be prevented or if the pain does not decrease but becomes more intense, the injured person must be admitted to the hospital

**Figure 2.** Bristleworm (*Hermodice carunculate*)

[18]. In local cases, oral painkillers such as acetaminophen or ibuprofen are sufficient. Local anesthetics, topical antihistamines and glucocorticoids, and systemically applied analgesic and antihistamine drugs are preferred after jellyfish injuries. Immediate intervention is essential in case of systemic reactions (shock, breathing difficulties, etc.). In a life-threatening situation, oxygen administration with airway support, intravenous fluid support and sympathomimetics for extreme hypotension are necessary. For hypersensitivity reactions, glucocorticoids are administered to the patient systemically. Patients showing systemic signs and symptoms should be kept under observation for at least eight hours [18–22].

Clues to the type of jellyfish include the geographic region where the sting occurred, common types of jellyfish washed ashore, distance from shore, and the tentacle pattern on the skin. For many patients, the specific species of stinging jellyfish is unclear, and management is based on species common in the area. It is important not to touch jellyfish during activities such as swimming and diving [23].

Sea anemone (*Parazoanthus axinellae*). These animals are found in most diving spots and can cause itching, burning, redness and blister formation on contact. Their treatment is similar to that of jellyfish, but the symptoms take longer to resolve [24].

Bristleworms (*Hermodice carunculata*, Fig. 2) are slow-swimming and non-aggressive. The most common cause of sea bristle worm-related injuries occurs when careless divers encounter these worms. The hairs they carry can inject a powerful neurotoxin when they come into contact with the skin. The most common symptom is a raised, red and itchy rash on the skin with a burning and stinging sensation. Redness and itching may last 2 to 3 days. All large visible hairs should be removed carefully to avoid breaking the spines or embedding them further. Their treatment is similar to that of jellyfish stings [25].

Long-spined sea urchin (*Diadema setosum*, Fig. 3). It is one of the species that came to our country from the Red Sea. It is common, and its spines are very fragile due to their calcium carbonate structure. Some have an acetylcholine-like toxin. In case of stinging, redness, swelling and pain occur; the thorns must be removed before they break or increase tissue damage. After injury, thorn tips can cause a black spot on the skin. The wound site should be immersed in salt water at the highest tolerable temperature [45 °C (113 °F)] as soon as possible and continue this application for 30 minutes (maximum 90 minutes) or until the pain subsides. Pain can be addressed with oral opioids or local anesthesia. The main problem in these injuries is the thorn fragments that may remain at the sting site and their removal. Soft tissue radiography, ultrasound, or MRI can be used to detect the presence and location of fragments. The patient should be followed up appropriately, and if symptoms persist, removal of any remaining particles should be considered. Late-formed granulomas, caused by thorn tips breaking off and remaining in the wound, may require lesion excision. Stinging of the thorn in the joints may cause synovitis [26, 27].

Greater weeverfish (*Trachinus draco*) and streaked weeverfish (*Trachinus radiatus*). The spines behind its pectoral and dorsal fins contain toxins and are hidden in the sand in the evening. In case of contact, it causes severe and sudden pain, redness and widespread swelling. The pain usually reaches an unbearable point within 30 minutes, and it may

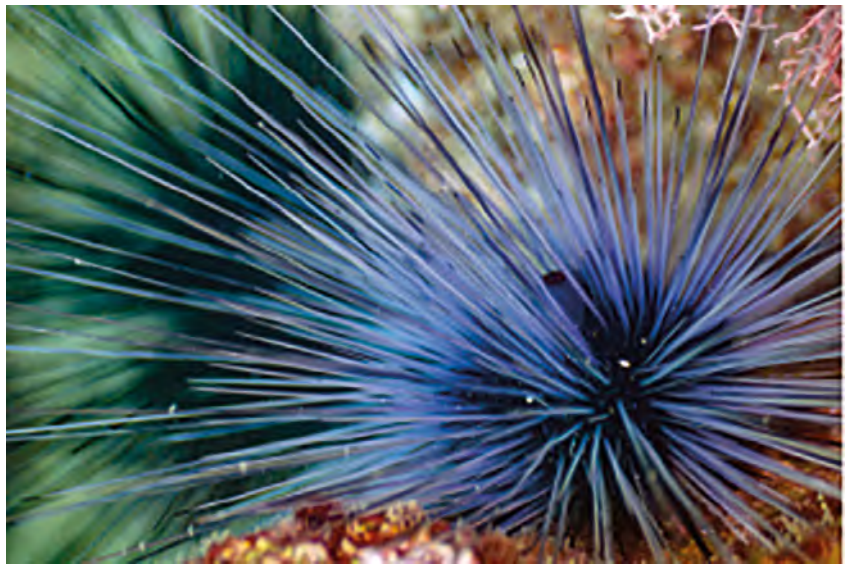

**Figure 3.** Long-spined sea urchin (*Diadema setosum*)

take up to one month for the symptoms to subside. It may also cause systemic symptoms such as headache, dizziness, fever, cold sweat, delirium, nausea, vomiting, bruising, joint pain, loss of speech, bradycardia, palpitations, mental depression, convulsion, and dyspnea. Secondary infections are common when appropriate treatment is not applied. In such cases, antibiotics are required. The treatment involves removing foreign objects and applying the highest tolerable temperature (about 45 degrees) to the affected area for 30–90 minutes to remove the remaining poison. Cold application increases pain. Usually, simple pain relievers such as acetaminophen or ibuprofen will provide relief, but if not, morphine may be necessary. Local painkiller injection or regional nerve block can be applied. However, hot water should be applied to patients whose pain is relieved with this method. Protection against tetanus is provided. In cases of allergic shock, steroids should be given to the patient. Additionally, traconia antidote was produced in 1968 and has been manufactured ever since. The use of such an antidote is limited to patients who do not respond to other treatment [28–31].

Economically valuable fish such as slender Rockfish (*Scorpaena elongata*) and Red Scorpionfish (*Scorpaena scrofa*) have toxin-containing glands on their dorsal fins. If stung, they cause local symptoms with severe pain. Their toxins are effective even after the fish has died. The treatment is similar to that of a sting from a striking fish [25].

Monkfish (*Lophius piscatorius*). The liquid covering the body of fish found in the Aegean and Mediterranean regions causes contact dermatitis. Topical steroids are used, and if the symptoms do not regress, oral or parenteral steroid treatment is applied [25].

Stonefish (*Synanceia verrucosa*) originating from the Red Sea. A stonefish caught off the coast of Yumurtalik (Iskenderun Bay) is reported for the first time from Turkey and for the second time from the entire Mediterranean. Stonefish, known for the powerful poison they carry in their spines, pose a potential danger to human health if they form successful populations in the region. The treatments is similar to that of a sting from a striking fish. If the injured area goes into necrosis, surgical debridement may be required [25].

Lionfish (*Pterois miles*, Fig. 4) originating from the Red Sea. It has poisonous spines located on its pectoral fins. The injured person must be removed from the water and taken to a safe area. Visible thorns and all other foreign objects should be carefully removed. For pain management, the wound area should be immersed in 40-degree water for 30–90 minutes. The injured area should be elevated to reduce swelling. Allergic and anaphylactic reactions should always be considered. Antihistamine, corticosteroid, adrenaline and medication should be administered quickly if necessary. Basic vital signs, temperature, pulse, blood pressure, respiratory rate and rhythm, central venous pressure, pulse oximetry should be monitored, and necessary interventions should be made in case of deterioration. For severe and extensive lesions, radiological evaluation can help evaluate significant tissue damage and necrosis in the wound. In such case, surgical debridement should be performed immediately [32, 33].

Red Sea-origin puffer fish (*Lagocephalus sceleratus*). It is often found on rocks and lives at depths of 10 to 50 meters. The fish found in Turkish waters is poisonous. Its spines and viscera contain tetrodotoxin, which block neuromuscular junction transmission, causing muscle paralysis. Twenty minutes after eating the fish, numbness begins in the tongue and lips. Paralysis develops in the face, arms

**Figure 4.** Lionfish (*Pterois miles*)

and legs. Headache, nausea, vomiting and abdominal pain occur. In the next stage, speech difficulty, breathing difficulties occur, heart arrhythmias and death occur [34, 35].

Rough tail stingrays (*Dasyatis centroura*) are known for their spiny tails, which include a single large poisonous spine. They can sting people with this spine. Most injuries involve the feet and legs. The wound resulting from the sting is both deep and poisonous. Pain from a stingray wound can be excruciating and may be accompanied by bleeding, weakness, vomiting, headache, fainting, and shortness of breath. Patients with jellyfish or sea anemone stings do not have puncture wounds. In the first intervention, the wound should be washed with sea water and the wound area should be immersed in water (45 °C) hot enough not to burn for 30–90 minutes. This may provide a pain-relieving effect. Hot water immersion should not be used for more than 90 minutes.

Patients may receive nonsteroidal anti-inflammatory drugs (e.g., ibuprofen) or acetaminophen for mild pain, and opioids (e.g., intravenous morphine) may be used for moderate to severe pain. If pain persists, local or regional anesthesia may also be required. The patient who has been given local or regional anesthesia should not be immersed in hot water. If the stingray's spine remains inside and can be removed without damaging other tissues, it can be removed. However, if the spine has damaged a vein or penetrated the rib cage or abdomen, it should be left in place until the patient reaches the hospital, regardless of the pain. It must be removed surgically after additional evaluation methods in the hospital. Tetanus prophylaxis should be administered if necessary. It should be done for small and clean wounds if there have been less than 3 doses or if there are 3 or more doses but 10 years or more have passed. In large and dirty wounds, if less than 3 doses of vaccine have been received or if the patient does not know, human tetanus immunoglobulin should be administered. If there have been three or more doses but 5 years or more have passed, a tetanus vaccine should be given [27].

Patients with deep puncture wounds, especially those with foreign body involvement and penetrating wounds caused by stingrays, require prophylactic antibiotics effective against Vibrio species and skin flora until the results of wound cultures are available. Empiric antibiotic therapy for water-exposed wounds typically consists of either a first-generation cephalosporin (e.g., cephalexin or cefazolin) or clindamycin plus levofloxacin in patients at risk for Methicillin-resistant Staphylococcus aureus or penicillin allergy. Patients exposed to seawater should also receive doxycycline for coverage of Vibrio spp. Tetracycline antibiotics can cause permanent tooth discoloration in children younger than 8 years when used repeatedly. However, doxycycline binds less readily to calcium than other tetracyclines and can be used for ≤ 21 days in children of all ages. Fluoroquinolones may also be acceptable for use in children in this situation due to the lack of other options that allow oral therapy.

Additionally, infections from marine injuries may be caused by normal skin flora. Therefore, antibiotic coverage should also include antibiotics with activity against Staphylococcal and Streptococcal species (e.g., cefazolin or cephalexin when the likelihood of clindamycin, vancomycin, or methicillin-resistant *Staphylococcus aureus* is low) [36–39].

Sandbar shark (*Carcharhinus plumbeus*). In attacks on surface swimmers, 70% of injuries occur below the knee. Since

sharks do not have the ability to chew, they tear off the piece they bite. The important thing in case of injuries caused by sharks is to quickly get the diver out of the sea to prevent severe tissue injury and hemorrhagic shock. Patients may be exhausted, hypothermic, and near drowning. The patient should be taken out of the water long enough to perform emergency resuscitation practices. In the hospital setting, treatment should be given the same level of priority as other major traumas. For diagnosing possible fractures, periosteal stripping, and foreign materials such as tooth fragments that may be trapped in the wound, plain radiographs of all wound sites should be taken, and samples should be taken for culture.

Although small wounds can be treated with irrigation and topical antibiotics, operating room conditions may be required for intervention in large wounds. Tissues that have lost their circulatory connection should be reconnected and the wound should be washed with plenty of water. Plastic surgery and repeated surgeries may be required even months after the attack [40–42].

A high rate of wound infection occurs with atypical microorganisms. Prophylactic antibiotic administration is required for all shark bites. Antibiotic selection should include coverage for Vibrio, Staphylococcus and Streptococcus species. The presence of enteric and anaerobic organisms should be considered in patients with abdominal injuries. Tetanus vaccination should be given if necessary.

The most common reasons why attacks result in death are the lack of resuscitation, hemorrhagic shock or suffocation from the injury site to the hospital.

Moray eel (*Murena helena*) is a species that generally lives in cavities. Although it does not have toxins, it can cause infection if it bites due to poor oral hygiene. For diagnosing foreign substances such as tooth fragments that may remain in the wound, plain radiographs of all wound areas should be taken, and samples should be taken for culture. If it is on the hand, foot, or near a joint, antibiotic prophylaxis should be started. Ciprofloxacin, trimethoprim-sulfamethoxazole or doxycycline may be preferred against Vibrio bacteria. A moray eel bite is not primarily sutured; it is left for secondary healing. If necessary, tetanus vaccination is given [25, 43].

## DISCUSSION

In Turkish waters, injuries due to venomous sea creatures such as jellyfish, greater weeverfish, scorpionfish, lionfish and puffer fish have been frequently reported. In an article written by an author from Israel, which has a coast on the Mediterranean, the injuries were caused by stingrays (30%), wild fish (22%), rabbit fish (13%) and sea catfish (10%), a new Red Sea immigrant [44].

The last report of a non-fatal attack by a shark in Turkey was on August 26, 2019. Two divers who were diving for routine inspection and cage cleaning were attacked by sandbar shark. The shark attacked divers while they were cleaning dead fish from outside the cages. Although the sea bottom where the fish farm's cages are anchored is 47–68 meters, the attack occurred at a depth of approximately 20 meters. These events were thought to be caused by the presence of dead farmed fish [40].

A total of 13 shark attacks were reported between 1930 and 1983, and two attacks were fatal [41].

In another case, a 30-year-old male patient working in a fish restaurant applied to the emergency room with complaints of pain, swelling and redness in the third finger of his right hand after he was stung while cleaning a fish. The patient had complaints of dizziness, severe pain in the right arm, nausea and sweating [31].

Accident reports in Turkish waters are compiled from case and news reports. While the poisonous creatures living in Turkish waters are known, there is no statistical data on how swimmers, divers and fishermen are affected by these creatures.

Scombroid poisoning occurs after eating fish that has spoiled because it was not stored properly. Initially, its relationship with tuna and mackerel fish in the subgroup Scombridae was described, and later it was determined that poisoning could also occur with other dark-fleshed fish. It is necessary to distinguish food poisoning from poisoning caused by eating fish. Diagnosis is based on history and clinical appearance. However, if confirmation is necessary, histamine levels can be measured in uneaten parts of the suspected fish [45–48].

## CONCLUSIONS

The cause of accidents and dangerous situations that may occur underwater is usually the diver's own faults and mistakes. In the marine environment, the victim is sometimes accidentally touched without seeing the creature they are exposed to, or even if a stinging fish is seen, the victim may know which species it is. Only a small portion of underwater accidents are caused by sea creatures. Recognition of marine-related infections is often delayed because the possibility of exposure to or injury in the marine environment is often not remembered.

Addressing marine environment injuries begins with getting the victim to a safe environment outside of the water. Afterwards, it is important to control the pain and calm the person down. Meticulous wound care should be performed. The wound should be washed for a long time, the severed tissue pieces are brought together, and any foreign substances remaining in the wound should be detected and removed. It is widely accepted that symptoms and treatments may vary between individuals. For

the treatment of marine environment injuries, prophylactic antibiotics should be started, and tetanus prophylaxis should be applied when required.

In the seas of Turkey, which are in the temperate climate zone, there are very few marine creatures that can be considered dangerous compared to those in warmer seas. From this perspective, our seas can be said to be among the safest in the world.

In this paper, we aim to remind readers of the precautions and first aid to be taken in such situations. This is one of the first studies designed to enhance emergency department physicians' and general practitioners' recognition and management of harmful marine life encounters in Turkish waters.

## ARTICLE INFORMATION AND DECLARATIONS

**Data availability statement:** Data is available upon request.

**Ethics statement:** This study has been conducted according to the ethical rules.

**Author contributions:** Conceptualization, Y.A. and A.S.Y.; methodology, Y.A. and A.S.T.; software, Y.A. and A.S.Y.; validation, A.S.Y. and Y.A.; formal analysis, Y.A.; investigation, Y.A. and A.S.Y.; resources, A.S.Y.; data curation, Y.A. and A.S.Y.; writing original draft preparation, Y.A.; writing, review and editing, Y.A. and A.S.Y.; visualization, A.S.T.; supervision, A.S.T.; project administration, Y.A. and A.S.T.; All authors have read and agreed to the published version of the manuscript.

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# Neglected tropical diseases in East Africa on the example of Madagascar

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## ABSTRACT

*Neglected tropical diseases (NTDs) are a group of tropical infections that are prevalent in tropical and subtropical countries; they usually stem from poor sanitation and poverty. People affected by NTDs are at risk of various disabilities, disfigurement, and social stigma. Most NTDs are chronic and debilitating illnesses whose treatment generates huge costs and puts a strain on individual and national budgets, especially in developing countries in Africa, Asia, and Latin America. The present article is a review of neglected tropical diseases which are found in East Africa; the study is based on the analysis of the NTDs prevalence in the Malagasy population. Madagascar is one of the poorest countries in the world. Approximately 35% of its residents do not have access to toilets and practice open defecation, and nearly 50% do not have access to safe drinking water. Other factors which are associated with a high prevalence of NTDs in local communities include limited access to healthcare, misinformation, and lack of food safety supervision.*

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**Keywords: neglected tropical diseases, epidemiology, Africa, Madagascar**

## INTRODUCTION

Madagascar is one of the poorest countries in the world. It is estimated that more than 80% of its population lives in extreme poverty with a daily income of 2.15 USD only. The country's human capital index score, based on the health and education components, is only 0.4, which reflects poor productivity as a future worker. The country's population has been estimated at 31 million in 2024, with an annual growth rate of 2.44%, and a total fertility rate of 4.11 live births per woman. Children aged 0–14 years account for 40% of the Malagasy population. On the one hand, the demographic data are disturbing because high population growth makes it difficult to fight poverty, but on the other hand, the statistics give hope for a generational shift which can be beneficial for the country in the future [1, 2]. The country's economy is heavily impacted by political and environmental difficulties as well as by the health problems of its people. Madagascar struggles with recurrent outbreaks of diseases, high rates of protein-energy malnutrition, diabetes and elevated maternal and neonatal mortality. There were 23.97 deaths per 1,000 live births registered in 2022, and the under-five mortality was reported to be 65.76 per 1,000 live births in the same year. Both parameters show an upward increase in Malagasy neonatal and under-five mortality compared to previous years and are they higher than the global average, which is concerning. Madagascar has one of the highest rates of stunting in children under 5 years old (approx. 50% of children are affected). It is estimated that pollution including food and water contamination are directly responsible for 1 in 5 deaths in the paediatric population. Open defecation is common in Madagascar; an

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estimated 35% of the Malagasy people do not have access to household toilets, and only 52% (35% in rural areas) have access to safe drinking water [3, 4–7]. Prematurity, low birth weight and high rates of child morbidity and mortality are associated with a high prevalence of anaemia in Madagascar. Anaemia, which is a common health problem in low-income countries, can lead to developmental disorders in children and eventually to low productivity as a future worker [8]. Anaemia has been defined as a drop in haemoglobin concentration below 12 g/dL in females and 13g/dL in males. It is associated with reduced oxygen-carrying capacity of erythrocytes which leads to hypoxia. Hypoxia has been demonstrated to affect concentration and attention and has a negative impact on a person's cognitive ability [9]. In low-income countries, anaemia is usually caused by dietary deficiencies, genetic disorders of haemoglobin, infections and inflammatory conditions [10], such as neglected tropical diseases (NTDs) among others. Most NTDs are chronic, debilitating conditions whose treatment generates huge costs and puts a significant strain on individual and national budgets, especially in developing countries in Africa, Asia, and Latin America. It is difficult, if not impossible, to solve all health-related problems in countries with high rates of poverty. One of the reasons for this is poor access to healthcare services, which facilitates the spread of infections, and a lack of monitoring and adequate treatment of diseases. NTDs can cause cognitive and behavioural impairment and result in lower productivity thus reducing a person's potential to earn money and become financially independent. The cost of treatment of some illnesses often exceeds the financial capabilities of many households and therefore prevents full recovery. The spread of NTDs is also facilitated by a lack of access to safe drinking water and improper food handling practices. Madagascar is at a considerable risk of transmission of many NTDs due to its low socio-economic development and high population growth. The present article is a review of neglected tropical diseases that are prevalent in Madagascar. The article points to the negative effects of NTDs on the Malagasy people, such as educational challenges or decreased worker productivity, which in turn is a barrier to fighting poverty. The authors have searched the PubMed database to retrieve observational studies and controlled randomized trials concerning the subject matter.

## NEGLECTED TROPICAL DISEASES (NTDS)

Neglected tropical diseases (NTDs) are a group of tropical infections that are prevalent in tropical and subtropical countries; their occurrence is largely determined by poor sanitation and extreme poverty. NTDs are endemic in territories with limited access to health services and a high prevalence of vectors of infectious and parasitic diseases [11, 12]. The initial list of NTDs, which was published in the PLOS Medicine journal in 2005 included 13 conditions: human African trypanosomiasis, leishmaniasis, soil-transmitted helminthiases (ascariasis, hookworm, trichuriasis, strongyloidiasis), schistosomiasis, lymphatic filariasis, onchocerciasis, dracunculiasis and bacterial diseases (leprosy, trachoma, Buruli ulcer). A few years later, the World Health Organization (WHO) expanded the list by adding some other illnesses which it considered a major threat to global health (Table 1) [13, 14]. The literature mentions other NTDs that are not on the official WHO list of neglected diseases but are recognized as such by the PLOS Neglected Tropical Diseases Journal. These are chronic, debilitating illnesses which commonly affect populations experiencing extreme poverty. They include foodborne parasitoses (e.g. anisakiasis, trichinosis), toxocariasis and other larva migrans infections, amebiasis (including *Naegleria* spp. infections), babesiosis, balantidiasis, giardiasis, cryptosporidiosis and cyclosporiasis, *Plasmodium vivax* and other non-*P. falciparum* malaria, loaiosis, bartonellosis, tuberculosis, cholera, bacterial gastrointestinal infections (*Shigella*, *Salmonella*, *E. coli*), leptospirosis, melioidosis, relapsing fever, Q fever, arboviral infections other than dengue and chikungunya (zika, Japanese encephalitis, yellow fever), enterovirus 71 infections and related viruses, coronaviruses (including SARS-CoV-2), Eastern equine encephalitis (EEE), hand, foot and mouth disease (HFMD), henipavirus species infections (e.g., Nipah virus), hepatitis C and E, HTLV-1, HTLV-2 and other retroviral infections (other than HIV), Rift Valley fever, viral haemorrhagic fevers, group A Streptococcal disease, nocardia, noma, non-tuberculous mycobacteria (NTM), rheumatic heart disease, rickettsiosis (e.g. typhus group, spotted fever group), podoconiosis, scorpion sting envenomation (SSE) [15, 16].

The importance of NTDs is often underestimated due to their low mortality, however, it is important to note that people affected by NTDs are at risk of various disabilities, disfigurement as well as social stigma. NTDs stem from poverty and their prevalence is generally higher among women and children. Children affected by NTDs cannot attend school regularly, while adults are unfit to work. Neglected tropical diseases are chronic, debilitating conditions whose treatment generates huge costs and puts a significant strain on individual and national budgets, especially in developing countries in Africa, Asia, and Latin America. It was estimated that NTDs affect nearly 1.7 billion people globally, yet most of the cases could be successfully treated. Considerable progress in the fight against NTDs has been made since 2010 after the WHO had formulated and introduced a global plan to combat NTDs. Currently, 500 million people globally no

**Table 1.** List of the NTDs recognized by the World Health Organization [14]

| Neglected tropical diseases (NTDs) | NTDs recognized by the WHO |
|---|---|
| **Helminth infections** (and their vectors) | — dracunculiasis<br>— echinococcosis<br>— foodborne trematodes<br>— lymphatic filariasis<br>— onchocerciasis<br>— schistosomiasis<br>— soil-transmitted helminthiases (ascariasis, hookworm, trichuriasis, strongyloidiasis)<br>— taeniasis/ cysticercosis |
| **Protozoan infections** (and their vectors) | — Chagas disease<br>— human African trypanosomiasis<br>— leishmaniasis |
| **Ectoparasitic infestations** | — scabies and other ectoparasites |
| **Non-infectious diseases or conditions** | — snakebite envenoming |
| **Bacterial infections** (and their vectors) | — Buruli ulcer<br>— leprosy (Hansen's disease)<br>— trachoma<br>— yaws (endemic treponematoses) |
| **Viral infections** (and their vectors) | — dengue and chikungunya<br>— rabies |
| **Fungal infections** | — mycetoma, chromoblastomycosis and other deep mycoses |

NTDs — neglected tropical diseases

longer require interventions against one or more NTDs, and 42 countries have successfully eliminated at least one NTD. The introduction of NTD treatment and control strategies has had a positive impact on the healthcare sector in many developing countries.

More importantly, however, the elimination or reduction in NTD prevalence is crucial for the education sector as well as the labour market in developing countries. Efforts to eradicate infectious agents associated with cognitive impairment are an investment in human capital and a successful poverty reduction intervention. The available treatments for NTD control are effective and relatively inexpensive. For this reason, eliminating these diseases is one of the most cost-effective population-based health interventions. The interventions to combat NTDs are supported by the WHO, which initiated a global project titled *Ending the neglect to achieve the Sustainable Development Goals: a road map for neglected tropical diseases 2021–2030*, which sets out goals and milestones for the prevention, control and elimination of NTDs worldwide [17–21].

## GEOGRAPHY AND EPIDEMIOLOGY OF MADAGASCAR

Madagascar is the fourth largest island in the world; it has a total area of 587,000 km$^2$ and is located in the Indian Ocean approximately 400 km off the eastern coast of Africa. Masses of hot and humid air from the southeastern parts of the Indian Ocean bring heavy rains to Madagascar, especially to the east coast of the island. The average annual temperatures vary from 22°C on the east coast to 20°C in the central highlands (in July and August, which are the coolest months, the temperature drops to 16°C and night frosts can occur at higher altitudes). The average temperature on the west coast is 25°C, but it may rise to 40°C between December and January. The east coast of Madagascar is covered by forests, while the centrally located highlands have been cleared of the forests and are now dominated by fields and meadows often destroyed by the fallow farming technique. The west coast of Madagascar is covered by savannah scattered with isolated trees and shrubs which extends into steppes. The environmental contrasts mentioned above have a significant impact on the epidemiology and distribution of endemic diseases across the island [3]. Almost the entire territory of Madagascar experiences cyclones 3–4 times each year. Heavy rains that hit the country cause catastrophic floods which destroy the crops and cause contamination of water tanks which are a source of drinking water. Climate change and extreme weather events which hit the island increasingly frequently affect food security and contribute to poor waste management and inadequate sewage treatment. As air temperatures increase, water temperatures also increase, which promotes the development of pathogens and further deterioration of water quality. Water contamination caused by flooding combined with elevated air temperatures can increase the prevalence of vector-borne and food/water-borne diseases [22]. Health financing in Madagascar is below the recommended minimum level that is necessary to ensure basic health coverage for all citizens [23]. Although the healthcare sector receives funding from the state budget as well as the private sector and international donors in equal shares, it remains dramatically underfunded. For this reason, the country's medical services are incapable of conducting effective epidemiological surveillance and control of disease outbreaks. Like in many other African countries, people living in Madagascar have limited access to health care services. More than 60% of the country's residents live more than 5 kilometres from the nearest healthcare centre, often in very remote and difficult-to-reach areas without roads or communications. The healthcare sector is also severely understaffed. In 2018, there were only an average of 5 physicians, midwives, nurses or other healthcare practitioners per 10,000 citizens in cities, and in rural areas,

the access to healthcare was even worse [24]. Additionally, there are severe shortages of medicines and medical supplies in the country. Due to widespread illiteracy and a high level of socio-economic inequalities, the public healthcare administration is of very poor quality, which also affects access to healthcare and the quality of medical services [25].

## NTDs RECOGNIZED BY WHO IN MADAGASCAR

### SCHISTOSOMIASIS

Schistosomiasis (bilharziasis) is a parasitic disease found in 78 countries, including Madagascar. The cycle of *Schistosoma* spp. involves snails and mammals (humans, mice, dogs). The disease is transmitted through freshwater snails that release cercariae, which infect humans through skin penetration while swimming, bathing, or walking barefoot in contaminated water [26]. It is endemic in more than 90% of the districts, and the average prevalence of schistosomiasis in Madagascar reaches 89% [27, 28]. Urogenital schistosomiasis (*Schistosoma haematobium*) is more prevalent in the western and northern parts of the island (where the temperatures often reach above 28°C thus providing excellent breeding conditions for the intermediate host of S. *haematobium* – the snail *Bulinus obstuscopura*). Intestinal schistosomiasis, on the other hand, is more frequently found in the eastern, central, and southern parts of the country, i.e. in areas where the average temperatures are lower. Co-endemicity of both *Schistosoma* species is seen in the north-central and southwestern regions of the country [28, 29]. Schistosomiasis-related health problems often affect preschool and school-age children [22, 30]. Studies present high infection rates among children, with prevalence reaching 93.7% in the Marolambo District and 64.5% in the northwest [31–33]. An infection with *Schistosoma* spp. may manifest as fever, headaches, muscle pain, rash, haematuria, painful urination, bloody stools, anaemia in chronic cases, intestinal damage, and cognitive impairments. Schistosomiasis also contributes to malnutrition due to blood loss and reduced nutrient absorption [26, 34-38]. In 1998, Madagascar launched the National Programme for the Control of Bilharziasis aiming to reduce the incidence of schistosomiasis through mass deworming with praziquantel. All schistosomiasis control programmes in Madagascar which followed also involved preventive chemotherapy with praziquantel. However, the program has faced challenges, including geographical, socio-economic, and political factors, as well as the COVID-19 pandemic. Despite increased funding for healthcare, schistosomiasis remains a neglected health priority [28, 34].

### SOIL-TRANSMITTED HELMINTHIASES (STH)

Infections with soil-transmitted helminths [STHs: *Ascaris lumbricoides*, *Trichuris trichiura, Ancylostoma duodenale* or *Necator americanus* (hookworm), and *Strongyloides stercoralis*] affect more than a billion people worldwide. It is estimated that approximately 5.3 billion people globally are at risk of transmission of STHs. Collectively, STH invasions have the highest disability-adjusted life years (DALYs) of all neglected tropical diseases. Helminthic infections have a particularly devastating effect on children's health because they are commonly associated with malnutrition, stunted growth, and cognitive and developmental disorders [39, 40]. STHs are transmitted via the faecal-oral route, through ingestion of egg-contaminated food, eating with dirty hands, or through direct contact with human skin (hookworm) [41]. The prevalence rates of STHs in Madagascar have been estimated to be up to 94%, depending on the region. Most cases are reported on the East Coast [28]. A study into the epidemiology of STH infections which was carried out in areas in the proximity of the Ranomafana National Park (RNP) in central-east Madagascar showed that infection prevalence rates were 71.4% for *Ascaris lumbricoides*, 74.7% for *Trichuris trichiura*, 33.1% for hookworm and 3.3% for *Strongyloides stercoralis*. A total of 92.5% of the study subjects living in rural areas surrounding the RNP were found to be infected with at least one STH [40]. Greigert et al. [42] studied a group of adult patients treated at the Gastroenterology Department at a hospital located in northwestern Madagascar. They found that only 7.9% of the study subjects tested positive for a helminthic infection. Helminthiasis can have a mild clinical course and remain undiagnosed. However, both symptomatic and asymptomatic infections can progress into a chronic condition if they are left untreated. Chronic helminthiasis can lead to protein-energy malnutrition and iron deficiency anaemia. Blood loss associated with an STH infection usually results from the disruption of the intestinal epithelial and endothelial barrier integrity at the site of tissue penetration. Hookworms produce anticoagulants which prevent blood clotting, but also digest the host's erythrocytes, thus causing blood loss. It has been estimated that an adult *N. americanus* or *A. duodenale* nematode can ingest from 0.05 to 0.2 mL of blood per day, with an average daily blood loss of 26.4 mL in *A. duodenale*-infected adults [43–46]. There are not many reports which confirm a relationship between anaemia and strongyloidiasis, but there are studies which have demonstrated that strongyloidiasis is significantly correlated with poverty and is more prevalent in children with low birth weight and children affected by wasting [47]. The mechanisms responsible for blood loss in STH-infected individuals are highly complex and depend on the intensity of the infection; however, mechanical

damage of the mucosa at the site of the penetration, active capillary damage and the presence of anticoagulants secreted by helminths are the most important [48]. In recent years, many countries have made efforts to prevent STH transmission by implementing mass drug administration (MDA). WHO recommends MDA for STHs twice a year in endemic areas, especially in preschool and school-age children as well as adults who are at considerable risk of transmission. These recommendations, however, do not apply to all parts of Madagascar [34].

## LYMPHATIC FILARIASIS

Lymphatic Filariasis (LFs) is caused by the mosquito-borne *Wuchereria bancrofti*, *Brugia malayi*, and *B. timori* nematodes. An estimated 90% of LF cases are caused by *W. bancrofti.* Most LF cases have a mild clinical course, but there is a risk of developing a severe form of LFs which can cause disfigurement and physical disability resulting from severe lymphoedema of the limbs and/or the genitals (*elephantiasis*). Lymphoedema occurs as a result of lymphatic system dysfunction which impairs the lymph flow [49]. There are many reports which suggest a correlation between LF and anaemia. However, researchers are divided on the issue [50, 51]. LF cases that are found in Madagascar are primarily caused by *Wuchereria bancrofti*. As was mentioned before, LF can lead to permanent disability (e.g. lymphoedema, elephantiasis) and impose a significant psychological burden and social stigma on the affected individuals [52, 53]. LFs are endemic in Madagascar with cases having been reported for more than a hundred years. A nationwide study of the LF prevalence in Madagascar which was carried out between 2004 and 2005 showed that the disease is endemic in 98 out of 114 districts and that more than 18 million people required MDA for LFs [28, 52, 54]. At present, all residents in endemic regions receive preventive chemotherapy (albendazole and diethylcarbamazine) against LFs once a year (except for children under 2 years of age and pregnant women). The MDA programme was initiated in the districts lying on the east coast of Madagascar but had been gradually expanded to other districts over the next 10 years [52, 55]. The tests are conducted at primary schools around the country and involve children aged 6-7 years old. Garchitorena et al. [30] studied the prevalence of circulating filarial antigens (CFA) in communities inhabiting the southeastern parts of Madagascar that have been covered by MDA. All children involved in the study tested negative for CFA, the prevalence of CFA among the adult participants in two districts was found to be 3.5% and 9.7%, respectively. The study findings may suggest that there is a threat of disease recurrence in the region, however, the absence of CFAs in the paediatric population proves the effectiveness of MDA programmes and justifies their continuation.

## CYSTICERCOSIS

Cysticercosis is a zoonotic intestinal infection caused by parasites. Transmission occurs via ingestion of foods contaminated with eggs or pregnant proglottids of *Taenia solium.* After ingestion, the parasite's eggs or proglottids hatch into larvae which enter the bloodstream and invade the host's tissues and organs, where they develop into *cysticerci* in approximately 2 months. Cysticercosis can develop in any voluntary muscle. The larval invasion of the muscle is often asymptomatic, although in some cases it can cause inflammation, eosinophilia, fever or even progress to atrophy and scarring. When the larvae enter the central nervous system (CNS), they can cause neurological signs and symptoms (neurocysticercosis, NCC). NCC is the most common parasitic infection of the CNS and is the leading cause of acquired epilepsy in cysticercosis-endemic countries (NCC is responsible for 30% of all epileptic seizures in NCC endemic regions) [56, 57]. Although there are no reports which suggest a relationship between cysticercosis and anaemia, NCC can cause serious neurological signs and symptoms, including epileptic seizures, headaches, blindness, meningitis, dementia as well as executive deficits and memory impairment, which all result in significant reduction of the patient's cognitive function. The main factors determining the spread of *Taenia solium* infections include traditional pig farming, contact with infected excrement, poor food handling practices and lack of meat inspection. Pork is the most consumed meat in almost all parts of Madagascar, whereas beef and raw pork liver are rare. For this reason, it is assumed that the majority of all cysticercosis cases reported in the country are caused by *T. solium* rather than by *Taenia saginata* (which is found in infected beef) or *Taenia asiatica* parasites (usually found in pork liver) [28, 58]. Between 2012 and 2016, the Ministry of Public Health of Madagascar in cooperation with the Institut Pasteur conducted nationwide screening for schistosomiasis and STH infections among the Malagasy residents. The tests used the Kato-Katz technique, i.e., a technique used to detect helminth eggs in stool samples. The results showed cases of human taeniasis in 53 out of 114 districts in Madagascar [58]. Studies have shown that infection with *T. solium* is endemic in Madagascar, which translates into a high infection risk. The seroprevalence of active cysticercosis in Madagascar ranges between 7–28% (its prevalence is generally higher in the central parts of the island compared to the coastal regions). A study by Carod et al. [59] demonstrated that the prevalence of cysticercosis in the sample consisting of school-age children from the seven largest cities in Madagascar was 27.7%. The lowest prevalence was observed on the eastern coast of the island, while the highest prevalence was seen in the south of the country. The two main risk factors responsible for the transmission

of cysticercosis in Madagascar include traditional pig farming (close contact with animals) and exposure to contaminated faeces due to lack of access to toilets and open defecation practices (around 35% of people in Madagascar defecate in the open) [3].

## LEPROSY

Leprosy is an infectious disease caused by *Mycobacterium leprae* with an incubation period varying from 1–2 years up to several decades after initial exposure. The disease affects the skin and nerves and can cause disorders of the immune system and episodes of acute inflammation which can lead to neuropathy and the exacerbation of the existing symptoms, before, during and after treatment [60, 61]. Between 2006 and 2021, there were an estimated 1,500 new leprosy cases annually in Madagascar, of which 5% were seen in children. Madagascar is 1 of 23 high-priority countries for new cases of leprosy and disabilities and 50% of the country's districts are hyperendemic for leprosy (> 1 case per 10,000 people) [28]. Ortuño-Gutiérrez et al. [62] conducted a study into the prevalence of leprosy in 64 Malagasy villages. They found that there were only 8 villages without any leprosy cases, whereas in the other 56 villages, the prevalence ranged between 1 to 31 per 1,000 people. The highest rates of leprosy cases are reported from the Fianarantsoa province, in other provinces the prevalence ranges between 2 to 7 per 10,000 population. Efforts are being made to limit the disease prevalence to 1 per 10,000 population in all districts, however, this aim has not yet been achieved [3]. Continued efforts aimed to eliminate leprosy focus primarily on the diagnosis and treatment of cases as well as disability prevention and rehabilitation [28].

## MYCETOMA, CHROMOBLASTOMYCOSIS AND OTHER DEEP MYCOSES

Mycetoma is defined as a process during which exogenous fungi or actinomycetes penetrate deep into subcutaneous tissues (skin damage facilitates disease transmission) causing a chronic infection. Mycetoma is endemic in dry tropical climates, especially in rural areas. The disease is found in the southern regions of Madagascar in areas with semi-arid climates and flora mostly consisting of thorn bushes and shrubs (two species dominate in the region: *M. mycetomi* and *S. pelletieri*). Mycetoma damages soft tissues and bones. The disease is most prevalent in Africa [63]. Chromoblastomycosis (CBM) and sporotrichosis (SP) are other endemic mycoses which are reported in Madagascar. Both CBM and SP are telluric diseases which occur following an injury. CBM is most commonly caused by *Fonsecaea pedrosoi* or *Cladophialophora carrionii* and usually affects subcutaneous tissues, whereas SP is caused by *Sporothrix schenckii* by invading the lymphatic system of the arms and legs [64]. Pathogens which are responsible for the fungal infections can be found in the soil or on plants; transmission usually occurs via direct contact with an infectious agent (e.g. through a puncture wound or a scratch with a thorn) or through exposure of pre-existing wounds to contaminated soil. For this reason, pathogenic lesions are usually limited to upper or lower limbs and most commonly affect people working outdoors and performing manual jobs with bare hands and/or people walking barefoot outdoors [64]. Rasamoelina et al. [65] tested a group of 92 Malagasy people for CBM and SP. They found CBM cases in 18.5% and SP cases in 37% of the sample. CBM cases were more often found in the northeastern, eastern, and southern parts of the island, while SP cases mainly occurred in the central highlands.

## ARBOVIRAL INFECTIONS

Arboviral infections are a group of febrile illnesses, which are spread by arthropods (mostly by mosquitos). Patients with an arboviral infection usually present with non-specific symptoms such as fever, headaches, myalgia and arthralgia. In isolated cases, the infection may develop into a haemorrhagic fever characterized by haemorrhage, thrombocytopenia, hypovolemia, and eventually a shock [66]. Arboviral infections are detected in healthcare facilities providing diagnosis and specialized treatment for patients with influenza, malaria and fevers of unknown origin (FUOs). There are 11 such facilities operating in Madagascar [28]. Broban et al. [67] conducted a study to estimate the seroprevalence of three different arboviral infections in Madagascar (dengue, chikungunya, and West Nile fever) and determined risk factors for seropositivity. They found that 6.5% of the sample were seropositive for dengue, 13.7% were positive for chikungunya and 12.7% for West Nile fever. Infections with dengue and chikungunya were more prevalent in the eastern and northern parts of the island, whereas West Nile fever was found to circulate in all parts of the country. Dengue and chikungunya seropositivity was associated with the presence of forests, while West Nile virus seropositivity was primarily associated with the proximity of agricultural land and cultivated fields. In 2006, an outbreak of arboviral infections was reported in Toamasina on the east coast of Madagascar. A total of 38 of the 55 patients sampled tested positive for dengue or chikungunya. Retrospective interviews with 4,242 randomly selected residents demonstrated that 67.5% of those interviewed reported dengue-like symptoms during the outbreak [68]. In 2009, an increase in the number of cases of febrile illnesses associated with joint pain was reported on the east coast of the country. At the beginning of February 2010, a patient

from the Mananjary district was diagnosed with chikungunya, soon more cases were diagnosed, and an outbreak was declared [69]. Arboviral infections are currently not under surveillance in Madagascar.

## RABIES

Rabies is an infectious viral disease which is spread from animals to humans through direct contact (usually through a bite or contact of mucosa/open wounds with saliva or brain tissue of rabid animals). The clinical symptoms of rabies include hyperactivity, paralysis, convulsions, excessive salivation, photophobia, hydrophobia, hallucinations, hyperventilation, priapism and eventually death [70]. Rabies continues to be endemic in many countries around the world and is a major threat to public health globally. The control of rabies is complicated by a wrong perception of the importance of rabies prevention among healthcare workers in many developing countries. Downplaying the issue of prophylaxis leads to infections and deaths, especially in poorer communities living in rural areas [70–72]. An average of 10 human rabies cases are reported in Madagascar each year. Between 2018 and 2022, a total of 44 deaths from confirmed or suspected human rabies were reported; in the first quarter of 2023, there were another nine human deaths from rabies. As for animal rabies cases, a total of 632 suspected or confirmed cases were reported in Madagascar between 2016 and 2021, mainly in the dog population [28]. The World Health Organization (WHO) in cooperation with the World Organization for Animal Health (WOAH), Food and Agriculture Organization (FAO) and the Global Alliance for Rabies Control (GARC) adopted a global strategy for rabies control aiming at eliminating dog-mediated rabies by 2030. Elimination of dog-transmitted rabies would be the optimum strategy for preventing rabies transmission. To achieve this goal, it is necessary to collect *accurate data on the incidence* and true *burden of rabies*. For this reason, it is important to strengthen rabies surveillance and control at both the local and the national levels to provide reliable estimates that can be used by policymakers [73–75]. The first national vaccination campaign against rabies was organized in 2019 by the Ministry of Agriculture and Animal Husbandry (MAAH), which received 100,000 doses of animal vaccines from the GARC. However, the COVID-19 pandemic and other logistical issues hampered the project. As a result, no reliable data on dog vaccination coverage is available at present.

## TUNGIASIS

Tungiasis also known as chigoe flea, jigger or nigua is an ectoparasitic skin disease which is caused by *Tunga penetrans* sand flea. The fleas breed and are most active during the dry season. Animals such as dogs, cats, pigs and cattle are important hosts, therefore, close contact with these animals facilitates the spread of tungiasis. Transmission among people usually occurs while walking barefoot or in open-toe footwear (e.g. sandals) on the sand fleas-infected soils. If left untreated, tungiasis can lead to physical disabilities and mobility limitations, and eventually to life-threatening secondary bacterial infections, especially in patients with diabetes [28, 76]. Madagascar is one of the countries which carries the highest burden of the disease [77, 78] and was declared to be tungiasis endemic [79]. Between 2004 and 2007, sand fleas were endemic in nearly 90% of the districts and a nationwide study conducted in 2010 demonstrated that 10 million residents of Madagascar are at risk of developing tungiasis. A similar study, which was conducted in 2017, showed that the number of people at risk of tungiasis was 17 million, which was a sharp increase since the last report. Another study into the prevalence of tungiasis was conducted in two endemic foci of Antananarivo and Toamasina. 13.7% of the sample were found to be infected, and 75% of those infected were people living in rural areas [80]. Tungiasis control programmes in Madagascar are carried out in cooperation with the National Bureau for Risk and Disaster Management (BNGRC). However, following the events of 2009 and due to the lack of resources, the interventions were limited to the management of tungiasis-related complications and the programme was discontinued [28].

## SUMMARY

Madagascar is one of the poorest countries in the world and its climate, flora and fauna favour the presence and spread of vectors responsible for the transmission of infectious and parasitic illnesses. Its economy is primarily based on agriculture and traditional farming, which is normally associated with everyday exposure to animals that often serve as reservoirs of infectious pathogens. The factors which contribute to a high prevalence of NTDs among local communities include open defecation practices, limited access to health care institutions, misinformation, lack of food safety supervision, and lack of health education and knowledge about the prevention of vector-borne diseases. In recent decades, several projects to eliminate NTDs were launched in Madagascar. These public health programmes were primarily based on the administration of preventive chemotherapy to people living in NTDs endemic districts. Interventions to prevent, control and eliminate NTDs are beneficial for the economy and the education sector and have been widely regarded as a human capital investment and an effective poverty reduction strategy. Given the fact that the available interventions for NTD control are effective, relatively inexpensive and highly beneficial, eliminating these diseases is one of the most cost-effective population-based health interventions. It is important to conduct epidemiological surveillance of NDT cases across

the whole country and to monitor the progress and effectiveness of the interventions aiming to eliminate NTDs in order to remove the social stigma associated with NTDs from the poorest residents of Madagascar. NTDs are not just an individual tragedy of a patient and their family but rather a serious public health threat which has important implications for the whole of society. NTD-related health problems such as cognitive impairment, stunted growth in children, foetal disorders, and low productivity pose a significant barrier to breaking the cycle of poverty in many developing countries. The authors have also pointed to a significant relationship between the prevalence of NTDs and the prevalence of anaemia, which gives space for further multilevel research into the Malagasy community.

## ARTICLE INFORMATION AND DECLARATIONS

**Data availability statement**: The authors confirm that the data supporting the findings of this study are available within the article.

**Ethics statement**: not required.

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# Psychometric properties of Job Stress Scale among Malaysian Seafarers

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## ABSTRACT

***Background:*** *Job Stress Scale (JSS) by Parker and DeCotiis (1983) which consists of two dimensions: time stress and anxiety stress, is a relevant scale to seafaring context. The psychometric properties of JSS have yet to be examined in the Malaysian context.*

***Aims:*** *This study attempts to examine the reliability and validity of the Job Stress Scale (JSS) among Malaysian Seafarers.*

***Methods:*** *An online questionnaire was created and distributed to a convenience sample of 390 Malaysian seafarers from various social media platforms such as WhatsApp, Facebook, and LinkedIn.*

***Results:*** *The results support JSS as a multi-dimensional construct with two-dimension, time stress and anxiety stress. The JSS also has established convergent and discriminant validity. For validation through correlation with other related measures, organizational justice and work stress were correlated.*

***Conclusions:*** *The JSS has established psychometric properties and can be proposed to be used as a tool to assess work stress among seafarers.*

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**Keywords: job stress, Malaysian seafarers, psychometric properties**

## INTRODUCTION

Shipping is the most significant mode of transportation in Malaysia, constituting over 90% of the nation's import and export volumes [2]. Seafarers are the workforce responsible for operating the shipping industry and they play a crucial role in fostering Malaysia's economic growth [3]. Seafaring is categorized as one of the highly stressful and demanding occupations [4, 5]. Yet, seafarers' work stress differs from the work stress in other professions. Seafarers work in a distinctive and demanding environment which is far different from typical land-based occupations. The nature of work stress encountered by seafarers in their work environment is unique, shaped by the particular conditions prevailing on boards of ships [6]. The nature of their work environment which characterized as confined, isolated spaces, prolonged periods away from home, sharing both work and rest areas, enduring continuous working hours, and insufficient time for rest [7, 8]. The confined and restricted working environment for seafarers leads to them not being able to escape when facing any conflicts and they are also subject to a variety of natural elements, including storms, extreme temperatures, and other difficulties as well as unpredictable weather conditions [9, 10]. Aside from that, seafarers are also susceptible to safety concerns, facing various potential hazards such as accidents, injuries, and illnesses [6, 11]. Additionally, the nature of maritime work requires continuous operation around the clock, resulting in extended shifts and varying work hours for seafarers [12].

Stress studies among seafarers are primarily concentrated on work-related stress, given their immersion in sea-based employment. Studies have consistently shown that seafarers are the high-risk group prone to work-related stress [6, 11, 13, 14, 15]. The distinct attributes of seafaring, such as remote and secluded conditions, confined

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spaces, and the safety-critical aspect of ship operations, contribute significantly to this stress vulnerability [16]. Work stress among seafarers is conceptualized as a multidimensional construct [17]. Each of these dimensions represents a distinct aspect of the challenges and stressors faced by seafarers in their maritime work settings.

Individual and environmental factors are integral in the entire work stress process [18, 19]. Individual factors such as resilience and self-efficacy [20]; Doyle et al., 2016 [21]) while environmental factors such as social support and organizational justices contribute to work stress among seafarers [14, 22]. Resilience has emerged as a crucial construct, particularly in the studies among seafarers, where it functions as a protective factor and a buffer against stress [21]. Work stress among seafarers has been found to negatively correlate with resilience [5, 21]. This implies that individuals with higher levels of resilience tend to experience lower levels of stress. Self-efficacy, which is an individual factor, is a mechanism for exerting self-control over an individual's emotions, offering numerous advantages, especially in the management of stress. As a result, self-efficacy is closely related to stress [20]. Numerous studies have explored the relationship between self-efficacy and stress, consistently revealing a negative correlation between the two. In particular, individuals with higher self-efficacy levels tend to experience lower levels of stress. Moreover, self-efficacy has been underscored as a crucial factor for seafarers in maintaining self-management and job satisfaction, as highlighted in the work of Kim and Jang [23].

Next is instrumental support is a form of social support that involves assistance with tasks and errands which usually involves assistance within the job context without placing a strong emphasis on the emotional aspect [24]. Noteworthy research on the relationship between instrumental support and seafarers' work stress perception has been carried out by Doyle et al. [21] and McVeigh et al. [5]. Both studies identified a negative correlation between instrumental support and work stress among seafarers.

Organizational justice is one of the issues that is much related to work-related stress among seafarers and also a prevalent concern within organizations and has also received attention among seafarers [5]. Organizational justice pertains to the fairness of treatment that employees receive and the extent to which this treatment influences other job-related matters, as outlined by Moorman (1991) [25]. Organizational justice among seafarers is usually among those people from low and middle-income countries. Participants in these studies conveyed feelings of frustration and reported suboptimal interactions with their co-workers. This frustration may potentially indicate a level of discomfort that includes elements of work-related stress. Organizational justice is concerned with an equitable and fair working environment [5]. Numerous studies on organizational justice and work stress, conducted across various organizations, consistently reveal a negative correlation between organizational justice and stress. This implies that higher levels of organizational justice are associated with lower levels of stress [26–29].

In measuring work stress, there are a lot of existing scales that can be used to measure work stress [30–32]. The variety of scales has different underlying conceptualizations of work stress. That is why the identification of an appropriate scale is crucial for the accurate measurement of work stress [33]. The Job Stress Scale by Parker and DeCotiis (1983) [1] is relevant to the seafaring context. The JSS consists of two dimensions which are time stress and anxiety stress. Time stress and anxiety stress are two dimensions of work stress concerned among seafarers [34]. Time stress refers to stress that is experienced due to having limited time available [1]. Time stress typically occurs when people worry about being unable to complete their tasks within the required time frame. Time stress also happens when they feel the stress of having too much time for a certain task. Other examples of time stress would encompass working long hours, having minimal leisure time, encountering time constraints in the workplace, and experiencing reduced time for personal relationships [14, 35–37]. Time stress has been identified as one of the stress dimensions strongly associated with seafarers [34]. Research indicates that seafarers encounter time stress as a consequence of prolonged durations spent onboard, inadequate time allocated for family interactions, and challenges in achieving a work-life balance. Their apprehension is compounded by the necessity to work for economic sustenance while desiring more time with their families. Furthermore, their opportunities for leave and reunions with their families are restricted [38]. The demanding workload they contend with translates into diminished family time and extended periods of stay onboard [39]. Seafarers frequently contend with restricted leisure time, which exacerbates time stress [8, 40]. Distinguishing between working hours and free time poses a challenge for them, as both occur within the same confined space and environment onboard. Furthermore, seafarers also contend with time stress stemming from the operational culture aboard the ship during their tenure onboard. Borovnik [34] revealed in a study that time stress significantly influences sleep deprivation among seafarers, who must juggle cultural obligations, adhere to ship protocols, and manage time constraints. Workplace demands and regulations further compound time stress for seafarers, particularly during tasks that necessitate extended hours, such as the ship's turnaround. Turnaround denotes the duration a vessel spends at a port from arrival to departure [41]. Throughout this phase, seafarers endure

longer watchkeeping shifts, and the entire crew is involved in monitoring or loading activities. Consequently, this scenario can result in inadequate sleep, heightened fatigue, and elevated stress levels among seafarers [34].

Anxiety stress is characterized by feelings of discomfort [1]and is closely linked to individuals' perceptions of tension and apprehension [6]. In a work setting, anxiety stress is influenced by factors like role conflicts, structural elements, and information gaps. This type of stress arises from the cumulative effect of typical stressors [1]. Anxiety stress is also another dimension of work stress commonly occurring among seafarers when individuals feel discomfort, tension, and worry about their work [34, 42]. Research conducted among seafarers has revealed the presence of anxiety stress [6, 43, 44] identified anxiety stress as highly prevalent among seafarers. Those who experience anxiety-related stress are more prone to making incorrect decisions while onboard, potentially jeopardizing safety and security during voyages [45].

Previous literature has evidently shown the psychometric properties of the Job Stress Scale (JSS) has the acceptable value of Cronbach alpha which was 0.9 [46, 47]. JSS was initially developed by Parker and DeCotiis [1] and consists of 13 items. Studies reported the use of two versions of JSS which consist of 13 items [48–50] and 9 items [51–52].

Shukla and Srivastava [53] validated the Job Stress Scale by Parker and DeCotiis [1] in a sample of Indian employees. The study shows a maintained two-factor structure of JSS. However, out of 13 items, five items were removed as they did not meet the acceptable loading. On the other hand, Yilmaz [54] validated JSS in the Turkish sample, which also shows the maintained factor structure but two items out of 13 items were eliminated.

The inconsistencies in findings from the previous study might be attributed to the sample used in those studies. Considering the Job Stress Scale (JSS) by Parker and DeCotiis [1] as a relevant scale to the seafaring context and the psychometric properties of this measure have yet to be investigated in a sample of Malaysian Seafarers, this study aims to evaluate the reliability and validity of Job Stress Scale in the Malaysian context.

## METHOD

### RESEARCH DESIGN

The present research was a quantitative, cross-sectional research design.

### QUESTIONNAIRE TRANSLATION

The back translation process was conducted to the Job Stress Scale (JSS) with four experts, three language experts, and one content expert. The original version of JSS was first translated into Bahasa Malaysia by two authors who are bilingual (English and Malay). The translated version was reviewed for clarity, accuracy, appropriateness of language, and linguistic quality. Once the clarity and accuracy had been confirmed, one researcher did the back translation from the Malay version to English. The contents of JSS were evaluated to determine if they were culturally appropriate for Malaysian populations.

### SAMPLE

A total of 390 Malaysian seafarers met the criteria of holding a valid seamen card and registered with the Marine Department of Malaysia (Marine Department Malaysia, 2019). The seafarers are those with different positions such as officers, engineers, crew, and rating. The data was collected through an online questionnaire using the Google Form platform. The sample was recruited using a convenient sampling method due to restricted access to seafarers.

### DATA COLLECTION PROCEDURE

Ethical approval was obtained University Malaysia Terengganu. After approvals were obtained, an online questionnaire was created and shared through social media platforms such as WhatsApp, Facebook, and email. Responses were tracked by the researcher from the Google form.

### INSTRUMENTATION

**Job Stress Scale (JSS).** This JSS was developed by Parker and DeCotiis and was used to measure work stress levels in this study. This scale has 13 items with two dimensions which are time stress (8 items) and anxiety stress (5 items). The scale used Likert scale measures ranging from 1 (strongly disagree to 5 (strongly agree). The reliability coefficient of this measure has been found to have an acceptable value of Cronbach alpha was 0.9 [46, 47].

**The Dispositional Resilience Scale (DRS-15).** This scale developed by Bartone [55], was utilized as a questionnaire to measure resilience in this study. This instrument comprises 15 items distributed across three domains: commitment, control, and challenge, with five items per domain [56]. Respondents rate each item on a five-point scale ranging from "strongly disagree" to "strongly agree". The scale includes both positive and negative items, with nine positive and six negative items. This scale has accepted internal consistency which reported a value above a threshold level of 0.7 [5, 21].

**The New General Self-Efficacy Scale.** It was developed by Chen et al. [58], and serves as an instrument for assessing self-efficacy. This scale comprises eight items, the scale employs a 5-point Likert scale, allowing respondents to indicate their agreement level from "strongly disagree" to "strongly agree". The scale does not consist of distinct domains or subscales. Higher scores on this measure

correspond to elevated levels of General Self-Efficacy (GSE). Notably, this scale has demonstrated strong reliability coefficients in previous studies, with values of 0.88 and 0.91, respectively [23, 58].

**The Instrumental Support questionnaire.** This questionnaire is an adaptation of the one employed by McVeigh et al. [5] and Doyle et al. [21] to measure instrumental support. This scale employs a five-point Likert scale, allowing participants to indicate their level of agreement, ranging from "strongly disagree" to "strongly agree". The Instrumental Support questionnaire originates from the organizational employee survey, which assesses various aspects of the work environment within an organization. The reliability of the scale, as measured by Cronbach's alpha, was found to be 0.77, signifying an acceptable level of internal consistency reliability [5, 21].

**The Organizational Justice questionnaire.** This organizational justice questionnaire utilized in this study is adapted from Moorman [25], a widely recognized instrument for measuring organizational justice. This measurement scale comprises 18 items distributed across three domains: procedural justice (7 items), interactional justice (6 items), and distributive justice (5 items). Respondents provide their ratings on a 5-point Likert-type scale, where 1 corresponds to "strongly disagree" and 5 signifies "strongly agree". Notably, this scale reported good internal consistency reliability with Cronbach's alpha level above 0.7 [25, 59].

## DATA ANALYSIS

The questionnaire responses were first entered into SPSS Version 25.0. The demographic analysis was conducted using SPSS. The analysis of psychometric properties of JSS was conducted using Smart PLS which includes confirmatory factor analysis, convergent and discriminant validity as well as correlation with other related measures.

## DEMOGRAPHIC ANALYSIS

A total of 390 sets of questionnaires were used for data analysis. The seafarer respondents were predominantly male (98.5%), engaged in a contract scheme (72.9%), married (72.6%), Malay ethnic background (81.3%), with six years or more of sailing experience (72.6%), and had a combination of both local and international sailing experience (72.3%). In terms of professional roles, more than half (61.3%) held positions as officers and engineers. Table 1 depicts a summary of the respondents' demographic profiles.

## PSYCHOMETRIC PROPERTIES OF JSS

The assessment of psychometric properties was conducted using PLS-SEM. Before proceeding to PLS-SEM analysis, reliability was examined using Statistical Package for the Social Sciences (SPSS) and was at the accepted

**Table 1.** Demographic analysis

| Demography | Category | Frequency | Percentage |
|---|---|---|---|
| Gender | Male | 384 | 98.5 |
| | Female | 6 | 1.5 |
| Marital status | Single | 100 | 25.6 |
| | Marriage | 283 | 72.6 |
| | Widow | 7 | 1.8 |
| Race | Malay | 317 | 81.3 |
| | Chinese | 9 | 2.3 |
| | Indian | 24 | 6.1 |
| | Others | 40 | 10.3 |
| Position | Officer | 111 | 28.5 |
| | Engineer | 128 | 32.8 |
| | Rating | 69 | 17.7 |
| | Crew | 38 | 9.7 |
| | Catering | 12 | 3.1 |
| | Others | 32 | 8.2 |
| Years of Experience | 0–1 Year | 21 | 5.4 |
| | 2–5 Years | 86 | 22.0 |
| | 6–10 Years | 104 | 26.7 |
| | 11–20 Years | 128 | 32.8 |
| | 21 Years and above | 51 | 13.1 |
| Sailing Experience | Local only | 83 | 21.3 |
| | International only | 25 | 6.4 |
| | Local and International | 282 | 72.3 |
| Employment Status | | | |
| | Permanent | 81 | 20.8 |
| | Contract | 309 | 79.2 |

**Table 2.** Convergent validity

| Constructs | Items | Loadings | AVE | CR |
|---|---|---|---|---|
| Control | RS2 | 0.6 | 0.525 | 0.814 |
| | RS6 | 0.783 | | |
| | RS12 | 0.797 | | |
| | RS15 | 0.702 | | |
| Commitment | RS1 | 0.685 | 0.559 | 0.791 |
| | RS7 | 0.775 | | |
| | RS10 | 0.779 | | |
| Change | RS5 | 0.772 | 0.657 | 0.793 |
| | RS9 | 0.848 | | |
| Resilience | Control | 0.857 | 0.657 | 0.851 |
| | Commit-ment | 0.868 | | |
| | Change | 0.695 | | |
| Self-efficacy | SEF1 | 0.754 | 0.634 | 0.932 |
| | SEF2 | 0.851 | | |
| | SEF3 | 0.796 | | |
| | SEF4 | 0.819 | | |
| | SEF5 | 0.874 | | |
| | SEF6 | 0.857 | | |
| | SEF7 | 0.645 | | |
| | SEF8 | 0.75 | | |
| Instrumental support | IS1 | 0.676 | 0.529 | 0.848 |
| | IS2 | 0.678 | | |
| | IS3 | 0.767 | | |
| | IS4 | 0.771 | | |
| | IS5 | 0.737 | | |
| Procedural justice | OJ1 | 0.753 | 0.732 | 0.950 |
| | OJ2 | 0.792 | | |
| | OJ3 | 0.863 | | |
| | OJ4 | 0.873 | | |
| | OJ5 | 0.894 | | |
| | OJ6 | 0.919 | | |
| | OJ7 | 0.884 | | |
| Interactional justice | OJ8 | 0.833 | 0.740 | 0.945 |
| | OJ9 | 0.783 | | |
| | OJ10 | 0.869 | | |
| | OJ11 | 0.874 | | |
| | OJ12 | 0.905 | | |
| | OJ13 | 0.893 | | |
| Distributive justice | OJ14 | 0.929 | 0.9 | 0.978 |
| | OJ15 | 0.953 | | |
| | OJ16 | 0.967 | | |
| | OJ17 | 0.959 | | |
| | OJ18 | 0.936 | | |
| Organizational Justice | Procedu-ral | 0.853 | 0.698 | 0.874 |
| | Interac-tional | 0.865 | | |
| | Distribu-tive | 0.787 | | |
| Time Stress | TS1 | 0.669 | 0.54 | 0.891 |
| | TS2 | 0.774 | | |
| | TS3 | 0.731 | | |
| | TS5 | 0.722 | | |
| | TS6 | 0.738 | | |
| | TS7 | 0.746 | | |
| | TS8 | 0.768 | | |
| Anxiety Stress | AS1 | 0.816 | 0.597 | 0.879 |
| | AS2 | 0.810 | | |
| | AS3 | 0.855 | | |
| | AS4 | 0.790 | | |
| | AS5 | 0.554 | | |
| Work Stress | Time stress | 0.953 | 0.879 | 0.936 |
| | Anxiety stress | 0.922 | | |

threshold which for the overall Job Stress Scale, the value was 0.895, time stress has a value of 0.832, and anxiety stress was 0.824. Hence, it shows the reliability of this Job Stress Scale (JSS). Next is PLS-SEM analysis using Smart PLS 4. The Smart PLS consisted of a two-step approach comprising a measurement model and a structural model. In the measurement model stage, the assessment convergent validity and discriminant validity were evaluated. Convergent validity confirmed that the items accurately measure their respective constructs. The loading and average variances extracted (AVE) are equal to or higher than 0.5, and if the composite reliability is higher than 0.7, as recommended by Hair et al. [60]. According to Table 2, all the criteria to establish convergent validity have been met, indicating that convergent validity was established.

Next was discriminant validity. In line with the recommendation by Henseler et al. [61], the heterotrait–monotrait ratio of correlations (HTMT) was employed to assess discriminant validity. As depicted in Table 3, all HTMT values were found to be lower than 0.85, indicating that the discriminant validity has been established [62].

## ASSESSMENT OF STRUCTURAL MODEL

The validity correlation with other related measures was assessed through the assessment of the structural model. Hair et al. [60]proposed addressing collinearity issues by examining the variance inflation factor (VIF) values of all endogenous variables in the research model. According to the criteria established by Diamantopoulos and Siguaw [63], a VIF value below 3.3 is considered acceptable.

In this study, the results for the variance inflation factor (VIF) were found to be lower than the critical value of 3.3 as demonstrated in Table 4 confirming that collinearity was not an issue. To test the hypotheses developed for validity correlation with other related measures, a bootstrapping procedure was conducted [60].

The hypotheses were considered to be supported if the beta value was aligned with the hypothesis with a t-value ≥ of 1.645, a p-value ≤ 0.05, and if there were no null values between lower level (LL) and upper level (LL) for the confidence interval. Referring to the four conditions of a hypothesis to be supported mentioned in the previous paragraph, only one hypothesis was found to be supported. The remaining three hypotheses were unsupported, as indicated by the data presented in Table 4. The result of the hypothesis were as follows ; for the first hypothesis, H1, (Resilience) with work stress (β = –0.042, t = 0.567, LL = –0.180, UL = 0.061, p = 0.285), H2 , between self-efficacy and work stress (β = –0.050 , t = 0.775, LL = –0.140, UL = –0.067, p = 0.219) and H3, between instrumental support and work stress (β = 0.004, t = 0.057, LL = –0.079, UL = 0.140, p = 0.477), were found to be unsupported.

**Table 3.** Discriminant validity

| | AS | Change | Commit | Control | Distrib | Interact | IS | Proce | SEF | TS |
|---|---|---|---|---|---|---|---|---|---|---|
| AS | | | | | | | | | | |
| Change | 0.151 | | | | | | | | | |
| Commit | 0.365 | 0.885 | | | | | | | | |
| Control | 0.216 | 0.648 | 0.857 | | | | | | | |
| Distrib | 0.333 | 0.315 | 0.341 | 0.152 | | | | | | |
| Interact | 0.228 | 0.373 | 0.47 | 0.308 | 0.574 | | | | | |
| IS | 0.201 | 0.595 | 0.687 | 0.454 | 0.429 | 0.622 | | | | |
| Proce | 0.192 | 0.475 | 0.458 | 0.288 | 0.487 | 0.668 | 0.662 | | | |
| SEF | 0.194 | 0.578 | 0.772 | 0.673 | 0.197 | 0.363 | 0.617 | 0.322 | | |
| TS | 0.887 | 0.161 | 0.284 | 0.128 | 0.361 | 0.277 | 0.251 | 0.243 | 0.156 | |

Item RS 7 is deleted due to cross-loading

**Table 4.** Hypothesis testing

| Hypothesis | Relationship | Beta | Std Error | t-values | p-values | LL | UL | $f^2$ | VIF | Decision |
|---|---|---|---|---|---|---|---|---|---|---|
| H1 | Resilience → Job Stress | –0.042 | 0.073 | 0.567 | 0.285 | –0.180 | 0.061 | – | 1.782 | Unsupported |
| H2 | Self-efficacy → Job Stress | –0.050 | 0.064 | 0.775 | 0.219 | –0.140 | 0.067 | – | 1.838 | Unsupported |
| H3 | Instrumental support → Job stress | 0.004 | 0.067 | 0.057 | 0.477 | –0.079 | 0.140 | – | 1.871 | Unsupported |
| H4 | Organizational justice → Job Stress | –0.283 | 0.063 | 4.509 | 0.0 | –0.401 | –0.194 | 0.057 | 1.564 | Supported |

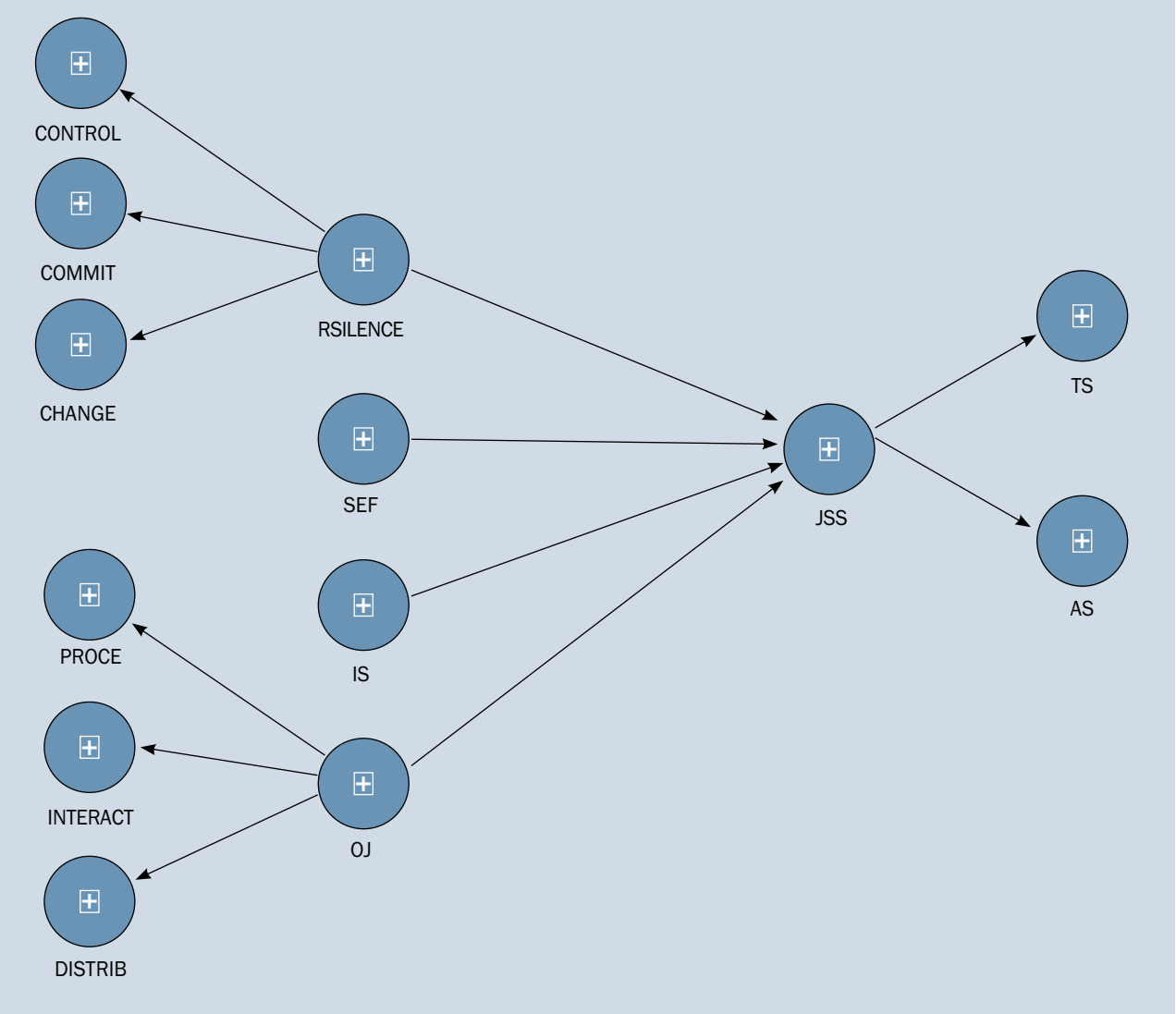


**Figure 1.** Structural model (PLS SEM)

Meanwhile, H4, Organizational justice is negatively associated with work stress (β = –0.283, t = 4.509, LL = –0.401, UL = –0.194, p = 0.00). Next is the effect size, which is only considered for the supported hypotheses. In this case, a large effect size was observed for the relationship between Organizational Justice and Work Stress. The analysis of the effect size is based on Cohen's guidelines, which categorize small, medium, and large effects of the exogenous

latent variable as 0.02 (small effect size), 0.15 (medium effect size), and 0.35 (large effect size), respectively [64]. The effect size assesses the degree or strength of the relationship within the latent variables. This evaluation is crucial because it enables researchers to determine the overall contribution of the research, as emphasized by Ngah, et al. [65].

## DISCUSSION

The findings support the Job Stress Scale (JSS) by Parker and DeCotiis [1] as a multidimensional one with two dimensions; time stress and anxiety stress similar to the original scale. Hence, supported the conceptualization of work stress by Parker and DeCotiis [1] and shows consistency in this Malaysian sample. It is important to note, that only item 4 was omitted "I frequently get the feeling I am married to the company". Most of the respondents in this study are contract-based workers and this is in accordance with what the International Labor Organization, a significant majority of seafarers, accounting for approximately 75% of the global population, do not hold permanent employment (ILO, n.d) [10]. Hence, feeling entitled to the company is not related to them because they are the contract worker. This is possibly the reason why this item is omitted.

The convergent validity and discriminant validity of JSS strengthen the validity of this scale. It implies the retained items are related to the constructs they are meant to measure [66, 67]. As validity correlation with other related measures, organizational justice, and job stress was supported. Organizational justice is indicated as a good predictor of work stress among seafarers. This finding is in accordance with previous studies' literature [27–29]. This strengthens that, fairness in treatment, employee treatment, and wages are practiced in the seafaring organization. Another possible reason is there is a balance between the efforts that have been made by individuals and the received rewards in the organizations which is stated by the effort-reward imbalance model by Siegerist [68]. In the framework of justice theory, effort-reward imbalance addresses the issues of organizational justice in the aspect of exchange and the perception of justice in the distribution of rewards depends on the efforts that have been made [69]. Therefore, individuals who experience an imbalance in terms of effort and reward may experience stress.

The other three hypotheses were unsupported. The first unsupported hypothesis is resilience and work stress. Despite the consistent literature suggesting a negative relationship between resilience and stress, this study presents a different perspective. One possible reason could be the presence of interferences within those relationships which might be influenced by mediating factors. In a study by Vaughan et al. [70], as well as Zhao et al. [71], demonstrated that the resilience-stress relationship is mediated by emotional regulation and social support. Individuals who are unable to regulate their emotions and lack good social support may not exhibit resilience. These mediation findings could potentially explain the inconsistencies in the resilience and work stress relationship, thereby accounting for the unsupported hypothesis found in this study.

Second, the next unsupported hypothesis is that self-efficacy is not negatively related to work stress. This finding aligns with studies by Klassen and Durksen [72] and Dwyer and Cummings [73]. Notably, research by Klassen and Durksen [72] on a longitudinal study on the relationship between self-efficacy and work stress. Initially, their hypothesis was supported; however, by the end of the study, the findings indicated no relationship between self-efficacy and work stress. The authors conclude that the diminished relationship is due to workers' long experience, which enabled them to better compartmentalize stress without it impacting their self-efficacy. Similarly, the absence of a negative relationship between self-efficacy and work stress in this study could be attributed to the experience factor, as the majority of participants had 11–20 years of work experience.

The third unsupported hypothesis is that instrumental support is not negatively related to work stress. This finding is consistent with Morelli et al. [24]. Social support consists of two types: instrumental support and emotional support [24]. Instrumental support refers to assistance obtained in tangible ways, such as transportation, personal care, or home help. This type of support lacks emotional engagement. The absence of an emotional connection in instrumental support could explain its lack of effect on well-being. It is likely that the seafarers in this study receive instrumental support but do not feel an emotional attachment, which could explain why it does not correlate with work stress. This could be a possible reason for the absence of a relationship between instrumental support and work stress in this context.

In conclusion, the Job Stress Scale by Parker and DeCotiis [1] has satisfactory psychometric properties that can be practically used in the Malaysian context. However, the limitation is restricted to the sample involved in this study. The sampling selection was non-probability hence, the generalization cannot be made. Future studies should be done in a larger sample, considering an onshore sample, so that the comparison of the findings can be made. The study also suggested to be conducted with various techniques of validity and reliability of the JSS.

One implication highlighted in this study is stress at work, contributing negatively to individuals and organizations. Although it is important to understand, individual perception of stress is one of the important factors in understanding the stress process [5, 21]. A stress-related factor may be

stressful to some individuals and for other individuals, it may not. However, looking at the nature of seafaring professions, with a dangerous working environment, confined and limited space as well as away from homes can create physical and mental health consequences. Studies have shown that work-related stress among seafarers significantly impacts safety, and medical health problems [18]. Diseases such as cardiovascular symptoms and gastrointestinal symptoms are also prevalent among seafarers [74]. Therefore, addressing this issue in terms of appropriate intervention for managing stress among seafarers is needed [18]. For example, MacLachlan et al. [75], pointed out that the concern regarding confined nature can suggest occupational health programs that could integrate work and leisure.

## ARTICLE INFORMATION AND DECLARATIONS

**Data availability statement:** Data available as supplementary information.

**Ethics statement:** This study was getting approval from University Malaysia Terengganu. This study was taking part voluntarily. All participants have been informed about this study.

**Author contributions:** The authors confirm the contribution to the paper as follows: Overall idea contributed by Siti Nazilah Mat Ali, Data analysis and discussion contributed by Ruhiyah Sakinah Kayati, Methodology contributed by Raja Zirwatul Aida Raja Ibrahim.

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**Conflict of interest:** There are no conflicts of interest.

**Supplementary material:** The supplementary material is in the form of a table and figure in a separate file.

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# Systematic review: Psychomental reactions of survivors after fatal maritime disasters at sea

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## ABSTRACT

***Background:*** *Several studies have shown that accidents and disasters at sea account for a significant share of seafarers' deaths. Additionally, the experience of a disaster often has a crucial impact on the mental health of survivors. The objective of this systematic review is to analyze the psychomental symptoms and their development over time after a maritime disaster, as well as the scores used to measure the severity of the symptoms.*

***Materials and methods:*** *A comprehensive literature search was conducted in the scientific databases PubMed, PubPsych, PsycArticles, and Scopus to identify studies related to fatal maritime disasters. This systematic search yielded 239 studies and twelve were ultimately included in the review after the application of specific exclusion criteria.*

***Results:*** *The included studies described the psychomental symptoms of 40 seafarers, 422 navy and US Coast Guard crew members, and 300 passengers who experienced maritime disasters. Survivors of fatal maritime disasters exhibit significant symptoms of posttraumatic stress and depression. The diagnostic screening cut-offs for post-traumatic stress disorder (PTSD) based on the Total Impact of Event Scale (IES-Total) score were exceeded in a significant number of the survivors. Although symptoms diminish over time, survivors' mental health often remains significantly affected for several years after the disaster.*

***Discussion:*** *The symptoms and the severity of PTSD and depression after a maritime disaster and their development over time show parallels with findings from land-based disaster research. Overall, the number of identified studies and their actuality in the field of maritime research are unsatisfactory. This highlights the necessity for additional research in the field of maritime disaster medicine.*

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**Keywords: maritime disaster, seafaring, post-traumatic stress disorder (PTSD), depression, anxiety, Impact of Event Scale (IES), Beck Depression Inventory (BDI), General Health Questionnaire (GHQ)**

## INTRODUCTION

The voyages of professional seafarers frequently last several months, with around 40% of the travel time spent on sea passage and around 20% on river passage [1]. Especially during these voyage episodes of sea and river passage, ship crews are largely left to their own devices. Frequent voyages to secluded areas, possible poor weather conditions and the generally limited medical resources on board are problems for seafarers' access to health care in case of emergencies and disasters [2]. Although a considerable amount of literature has been published in the field of disaster studies, there is no universally adopted definition

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of disaster [3]. For the purpose of this review, the definition of a "very serious marine accident" as defined in German law in § 1a Maritime Safety Investigation Law (SUG, *Seesicherheits–Untersuchungs–Gesetz*) is adapted and maritime incidents are considered disasters if they result in at least one fatality [4].

Despite rapidly declining fatality rates [5, 6] disasters and accidents on vessels remain a major and serious threat to seafarers' health and wellbeing; between 40% and 50% of seafarer deaths observed in a review of European studies were attributed to accidents and disastrous events at sea [7]. Additionally, a Danish study found that 59% of active seafarers' deaths occurred during sea passage and estimated that shipboard crews are six times more likely to die from occupational accidents than shore-based workers [5]. As there are usually no doctors on board and professional medical assistance is sometimes only available several days after the shipwreck, shipping disasters and medical emergencies are potentially critical and poignant experiences that may severely affect the mental health of seafarers. Following a fatal incident on board, the crew is often unable to depart the ship for several days, which may affect their ability to distance themselves from the incident and to process the associated trauma. The situation is further complicated by the possibility of dysfunctional responses by other affected survivors of the disaster.

The damage caused by a maritime disaster goes beyond the initial loss of life, as it has a profound impact on the survivors as well. In disaster research, the impact of a disaster on the psychomental well-being of survivors can be assessed, for instance, through the use of symptom measurement instruments such as the Impact of Event Scale (IES), General Health Questionnaire (GHQ) and the Beck Depression Inventory (BDI) [8, 9] which can provide standardized quantitative assessments of the manifestation of symptoms and may contribute to the scientific knowledge of the mental health consequences of disasters [10–12].

The findings of research on most land-based disasters have linked the experience of a disaster to the manifestation of mental disorders such as post-traumatic stress disorder (PTSD), depression, and anxiety [8, 13]. With this in mind, there appears to be a significant risk to the mental health of survivors of maritime disasters that needs to be understood by healthcare professionals and other organizations involved in the care of seafarers, such as the Seafarers' Mission, in order to best mitigate potential negative mental health outcomes.

While merchant seafarers are particularly vulnerable to maritime disasters in their line of work [7], this review also includes other populations, such as passengers and other occupational groups that spend significant time at sea, e.g. members of the navy or other public organizations such as the U.S. Coast Guard. Despite the significant differences between these groups (for instance in terms of average age, the role on board or the professional training), there are similar fundamental aspects of the disaster experience for all those involved in maritime incidents. For example, exposure to the same life-threatening hazards during a disaster (such as drowning, hypothermia, exhaustion) or to the death of strangers or even colleagues and friends, and the risk of negative psychomental consequences that may affect daily life after a disaster, remain constant regardless of group affiliation.

Because survivors of maritime disasters are exposed to relatively unique scenarios as described above, findings of general disaster research may not always be applicable and require further confirmation in maritime settings. Therefore, the objective of this review is to evaluate the type and severity of psychomental symptoms and their development over time in survivors after a fatal maritime disaster.

## MATERIALS AND METHODS

In order to analyze the psychomental symptoms after fatal maritime disasters, this systematic literature review was carried out through a search of several scientific databases. The databases PubMed, PubPsych, PsycArticles and Scopus were searched in May 2024 to identify relevant studies between 1984 and 2024. The databases were selected based on their extensive catalogs of scientific literature and their well-established relevance and credibility in medical and mental health research. Apart from the publication year, no further restrictions, such as the type of publication, were applied to the search in the databases. The following search string was used to identify studies relevant to this systematic review: *[(death at sea) OR (maritime disaster) OR (disasters at sea) OR (shipping disaster)] AND [(mental health) OR (psychosomatic symptoms) OR (psychological symptoms) OR (PTSD)].*

Several exclusion criteria were established in advance to narrow down the literature hits and to achieve the objective of this review. The exclusion criteria were applied sequentially at both title/abstract level and full-text level to identify the final results for this systematic review. Research hits without available abstracts and/or full texts in German or English language were excluded, as were hits that had no relation to seafaring, seafaring disasters with fatal outcomes or in which the focused study population was not directly involved in the fatal disaster (e.g. rescue workers). In addition, research that did not provide a sufficient quantitative description of the study population or mental health outcomes, and research that focused primarily on basic maritime scientific research (without reporting on symptom manifestation) was excluded.

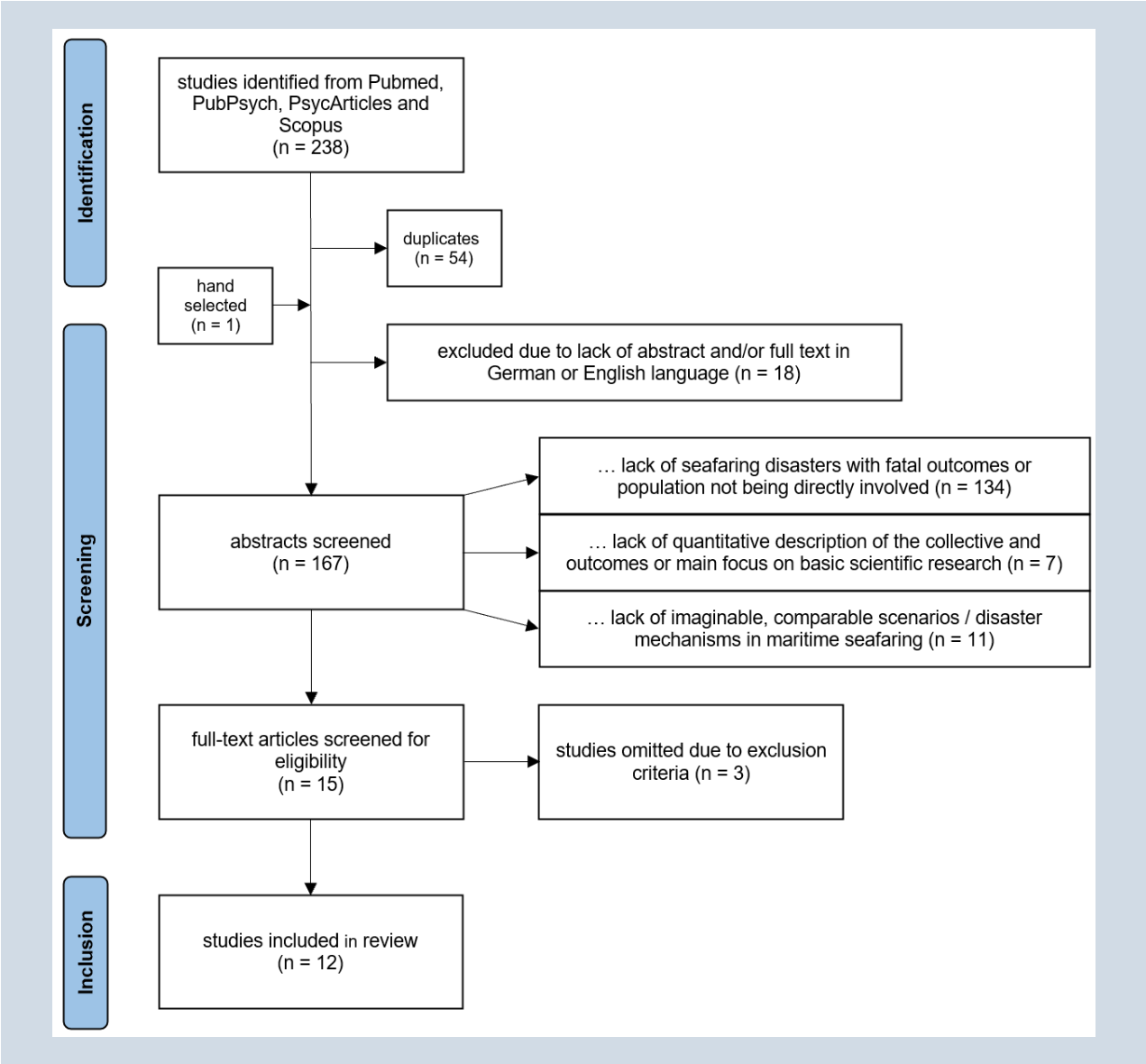


**Figure 1.** Identification, screening and inclusion process of research hits visualized in PRISMA diagram [14]

To achieve a higher degree of comparability between merchant seafarers, navy crew/US Coast Guard members and passengers the final exclusion criteria was introduced; studies were only included in this review if the disaster scenarios and mechanisms were conceivable in a merchant seafaring setting (e.g. no war experiences or studies that focused on the effects of the disaster on children). The identification and screening process is visualized in Figure 1. The study identification, selection and evaluation processes were conducted independently by three researchers to minimize potential sources of bias and to improve the reliability of this review.

The database search with the aforementioned string identified 238 search results, of which 54 were duplicates across the databases. Another 18 results were excluded because the abstracts and/or full texts were not available in German or English. With the inclusion of one hand-selected study, a total of 167 abstracts/titles were screened on abstract level.

A significant proportion of the studies had no relation to seafaring, fatal maritime disasters or the examined study population was not directly involved, and thus 134 records were excluded. In addition, seven studies lacked a quantitative symptom description or focused on basic maritime scientific research without reporting on the manifestation of symptoms. Finally, eleven military or civilian passenger studies were omitted from full-text review because a conceivable transferability of the disaster scenario to the maritime seafaring was not given.

This process resulted in 15 remaining studies for eligibility screening on full-text level. Of these, one paper was excluded as it did not provide a sufficient quantitative description of the mental health consequences of the disaster. Two further papers were excluded based on the final criterion since one disaster occurred during a military training exercise and was thus not applicable to merchant seafaring, and the other study investigated a population which was solely underage during the time of the disaster.

In their study Líndal and Stefánsson (2011) [15] examined fishermen, who are classified as seafarers in this review. Upon completion of the search and screening process, twelve studies were selected for inclusion in the subsequent review and analyzed. A particular emphasis was placed on the evaluation of psychological questionnaires because of their ability to serve as standardized and quantitative measures of psychomental symptoms. The time course of symptoms was taken into account when multiple observation periods were available.

## RESULTS

The twelve studies included in this systematic review were published between 1984 and 2011, five of which were published after the turn of the millennium. As shown in Table 1, two out of the twelve publications focused on merchant seafarers [15, 16] and two studies dealt with navy crew and US Coast Guard members [17, 18] — with the circumstances of one seafaring disaster allowing one additional publication to study both groups [19]. The remaining seven studies focused on passengers.

The study designs varied considerably. Cross-sectional and cohort studies were the most common, with four studies each. Case reports were also a frequent design and were used three times. Finally, Dalgleish et al. (2000) [20] presented a review summarizing a decade's worth of research on the survivors of the Herald of Free Enterprise disaster. The quality of the included studies was rated according to the Scottish Intercollegiate Guidelines Network (SIGN) [21] grading system and SIGN grades ranged from 2+ to 3. According to the SIGN grading system, two studies achieved a grade of 2+, followed by three studies with a grade of 2– and six studies with a grade of 3. As Dalgleish et al. (2000) [20] constitutes a review, it could not be rated on the basis of the SIGN system.

Overall, the aims of the studies as described by their authors (Table 1), the chosen intervals of observation after disaster and the contents of the investigation (Table 2) are heterogeneous. To distinguish between short-term and long-term symptoms, this review follows the approach of Newnham et al. (2022) [8], who defined long-term symptoms as those lasting more than twelve months. The following common trends seem to emerge from their combined analysis:

- to study the short-term and early effects of the disaster (9 of 12 studies) [16, 18–20, 22–26]
- to study the long-term and late effects of the disaster (6 of 12 studies) [15, 17, 20, 22, 24, 27]
- to examine possible influences (e.g. social support, prior health problems and feelings of guilt) on the development and/or severity of symptoms (6 of 12 studies) [17, 18, 20, 22–24]
- to study the impact of disaster characteristics (e.g. immersion in disaster, relatives perishing in disaster) on the severity of symptoms (6 of 12 studies) [15, 20, 22–24, 27]

Three of the included studies, Dalgleish et al. (2000) [20], Dyregrov and Gjestad (2003) [22] and Joseph et al. (1991) [24], contain aspects of all the trends, although it should be noted that the first mentioned paper is a review summarizing a decade of research on the Herald of Free Enterprise disaster. On the other hand, four papers are largely limited and/or have a dominant emphasis on the analysis of a single trend, with all of them focusing on the study of short-term and early effects of the disaster [16, 19, 25, 26].

In total eight different, unique maritime disasters were the basis for this review with an additional 20 small-scale disasters being reviewed by Líndal and Stefánsson (2011) [15].Two disasters were examined in multiple studies; the Herald of Free Enterprise disaster in 1987 was the basis for the analyses by Dalgleish et al. (2000) [20], Dooley and Gunn (1995) [27] and Joseph et al. (1991) [24], while the sinking of the MS Estonia in 1994 was the subject for Eriksson and Lundin (1996) [23] as well as Taiminen and Tuominen (1996) [25].

The maritime disasters that formed the basis for the included studies exhibit considerable variations in terms of the magnitude of the disaster (Table 3). At the time of disaster, the ships carried between 29 and 1038 people on board, with reported fatality rates ranging from 1 person (~1%) to over 900 persons (~87%). The median of total fatalities was 51 (39%). The disasters examined in the studies by Líndal and Stefánsson (2011) [15] and Tekin et al. (2005) [16] are not included in these ranges due to insufficiently precise descriptions.

Overall, the included studies collected information on 40 merchant seafarers (with an additional 88 seafarers in control group), 422 navy crew/US Coast Guard members (with an additional 387 navy crew members in control group) and approximately 300 passengers (Table 3). The mean age of all investigated survivors is approximately 35 years; however some uncertainty remains due to lacking, unclear or unspecific age descriptions.

The 88 seafarers included in the control group of Líndal and Stefánsson (2011) [15] were involved

**Table 1.** Overview and general information about included studies. Publications sorted by main population group investigated in study (study group)

| Author | Title | Study group | Pub. year | Vessel | Study design | Review-relevant aims of study | SIGN grade |
|---|---|---|---|---|---|---|---|
| Líndal & Stefánsson | The long-term psychological effect of fatal accidents at sea on survivors: (...) | seafarers | 2011 | smaller fishing boats | cross-sectional study | The goal is to determine whether survivors of small maritime disasters experience long-term symptoms of PTSD and whether the frequency or severity of symptoms correlates positively with the severity of the disaster. | 3 |
| Tekin et al. | A burn mass casualty event due to boiler room explosion on a cruise ship: (...) | seafarers | 2005 | cruise ship | case report | To review the experience and psychological sequelae of a boiler room steam explosion. | 3 |
| McCaughey | US Coast Guard collision at sea | seafarers & navy crew | 1985 | US Coast Guard ship | case report | To describe the emotional, psychological and physical symptoms of the survivors. | 3 |
| Eid et al. | Post-traumatic stress symptoms following shipwreck of a Norwegian Navy frigate - (...) | navy crew | 2001 | frigate | prospective cohort study | To conduct a short-term follow-up of post-traumatic stress reactions and to investigate whether contextual and individual factors are related. | 2+ |
| Hoiberg & McCaughey | The traumatic aftereffects of collision at sea | navy crew | 1984 | missile cruiser | prospective cohort study | To examine the psychological effects of a maritime collision by comparing the performance and psychiatric hospitalizations during a 3-year follow-up of the disaster Navy crew. | 2- |
| Dalgleish et al. * | The Herald of Free Enterprise disaster. Lessons from the first 6 years | passengers | 2000 | ferry | review | To address questions about the time course of symptoms, mediating and moderating factors of posttraumatic stress reactions and possible predictor variables of distress and psychological problems at later time points. | n.a. |
| Dooley & Gunn * | The psychological effects of disaster at sea | passengers | 1995 | ferry | cross-sectional study | To determine whether crude measures of the nature and/or severity of psychological stress or threat (such as immersion and bereavement) are related to severity of symptoms. | 3 |
| Joseph et al. * | Causal attributions and psychiatric symptoms in survivors of the Herald of Free Enterprise disaster | passengers | 1991 | ferry | prospective cohort study | To investigate the relationship between causal attributions and psychiatric symptoms and whether guilt is a possible predictor of more severe and prolonged reactions. | 2- |
| Dyregrov & Gjestad | A maritime disaster: reactions and follow-up | passengers | 2003 | catamaran | prospective cohort study | To report on the disaster survivor‘s reactions and their received psychosocial help. | 2+ |

**Table 1 cont.** Overview and general information about included studies. Publications sorted by main population group investigated in study (study group)

| Author | Title | Study group | Pub. year | Vessel | Study design | Review-relevant aims of study | SIGN grade |
|---|---|---|---|---|---|---|---|
| Eriksson & Lundin ** | Early traumatic stress reactions among Swedish survivors of the m/s Estonia disaster | passengers | 1996 | ferry | cross-sectional study | To assess the short-term impact on disaster survivors. | 2- |
| Taiminen & Tuominen ** | Psychological responses to a marine disaster during a recoil phase: experiences from the Estonia shipwreck | passengers | 1996 | ferry | case report | To describe the psychological reactions and corresponding behavioral patterns among disaster survivors during the first three days. | 3 |
| Thompson et al. | The Marchioness disaster: preliminary report on psychological effects | passengers | 1994 | riverboat | cross-sectional study | To describe the psychological after-effects on disaster survivors. | 3 |

* = Herald of Free Enterprise disaster; ** = MS Estonia disaster

in potentially life-threatening disasters, which remained without deaths, while the 387 navy crew members in the control group of Hoiberg and McCaughey (1984) [17] were recruited from the crew of a comparable vessel that was not involved in any disaster. The last control group was employed by Dalgleish et al. (2000) [20], who, in some aspects of their analysis, utilized a control group of matched participants.

## SYMPTOMS OF SURVIVORS AFTER MARITIME DISASTER

In the study by Líndal and Stefánsson (2011) [15], simple phobias, nightmares, sleeping difficulties and symptoms of hyperarousal were significantly more common in seafarers affected by fatal maritime disasters than in survivors of non-fatal disasters. Nightmares, sleeping difficulties, irritability, intrusive symptoms, exaggerated startle responses and symptoms of stress disorders were also reported by Tekin et al. (2005) [16] in survivors of a fatal maritime disaster. All but one survivor saw substantial reductions in symptoms eight weeks after the traumatic event.

Most of the survivors of the maritime disaster in the study by Taiminen and Tuominen (1996) [25] showed symptoms of the anxiety cluster, followed by the denial cluster (16.7%), acute specific phobias (15.8%), feelings of guilt, dissociative and depressive reactions (10.5% each). Similarly, diagnostic labels for anxiety disorders were also frequently applied to survivors in the maritime disaster study by Dooley and Gunn (1995) [27].

McCaughey (1985) [19] reported on the symptoms of seafarers and military officer candidates after a maritime disaster. The most common symptoms and reactions were fatigue, sadness, crying spells, irritability, vulnerability, shock, anger and guilt. Furthermore, officer candidates were much more likely to report decreased concentration than seafarers.

## SYMPTOM SCORES FOR SURVIVORS AFTER MARITIME DISASTER

A considerable number of standardized instruments were used in the included studies. However, only variants of IES, GHQ, Posttraumatic Symptom Scale (PTSS-10), BDI, State-Trait Anxiety Inventory (STAI) and instruments referencing diagnostic criteria of Diagnostic and Statistical Manual of Mental Disorders (DSM-III/DSM-IV) are used in at least two studies and are therefore displayed in Table 2. Impact of Event Scale (7/12), GHQ (5/12) and PTSS-10 (3/12) are the most used instruments. Both BDI and STAI are used twice — each in the same two studies. Instruments based on DSM-III or DSM-IV are also applied in two studies. In addition, four studies didn't apply any of these instruments. Lastly, ten instruments were used in only one study each (and are

**Table 2.** Observation intervals, methods and contents of studies, and use of standardized instruments. Publications sorted by main population group investigated in study and by descending frequency of the standardized instruments used. Only instruments that have been used in at least two publications are shown

| Author | Intervals of observation after disaster | Methods (contents) | Most frequently used standardized instruments | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | IES | GHQ | PTSS-10 | BDI | STAI | DSM |
| Líndal & Stefánsson | single observation within an average of 8 years | semi-structured interviews and open-ended questions | ✓ | ✓ | ✓ | | | |
| Tekin et al. | regular observations during hospital admission and at least one psychological follow-up after discharge | reviewal of patient's written and electronic records, observation and diagnosis by burn center psychology team | | | | | | |
| McCaughey | observations for 12 days, possibly up to one year for a few seafarers | examination of psychiatric records and observations by disaster intervention group, non-standardized questions (reactions to accident) | | | | | | |
| Eid et al. | first observation at 3 weeks, second observation at 4 months and third observation at 12 months | non-standardized questions (contextual factors such as time in navy crew and individual factors such as coping style) | ✓ | | ✓ | | | |
| Hoiberg & McCaughey | 3 years before and after disaster | data extracted from patient health and career history files covering time before and after disaster | | | | | | |
| Dalgleish et al. * | first observation within 1 year, second observation at 3 years and third observation at 6 years | open-ended questions and non-standardized questions (guilt, substance abuse) either by self-report data, postal questionnaires or personal visit | ✓ | ✓ | | ✓ | ✓ | |
| Dooley & Gunn * | at least one, sometimes multiple observations of patients assessed over >18 months | interviews, clinical notes, legal reports, special investigations and non-standardized questions (immersion, bereavement, psychiatric history and symptoms after disaster) | | | | | | ✓ |
| Joseph et al. * | written statements within ~3.5 months, first observation at ~7.5 months and second observation at ~19 months | psychological interviews, non-standardized self-report measures, extraction of information from documents (perceived internality and controllability of disaster and intensity of impact) | ✓ | ✓ | | ✓ | ✓ | |
| Dyregrov & Gjestad | first observation at 6 weeks and second observation at 18 months | non-standardized questions (disaster exposure, helpfulness of intervention meetings, perception of functioning before disaster, peritraumatic reactions and perception of help received) | ✓ | ✓ | | | | |
| Eriksson & Lundin ** | single observation at 3 months | open-ended questions, non-standardized questions (personal loss, coping abilities, exposure to dead passengers) and standardized instrument on basis of DSM-IV (especially measuring dissociative symptoms of acute stress disorder) | ✓ | | ✓ | | | ✓ |
| Taiminen & Tuominen ** | daily observations for the first three days | observations by crisis intervention group | | | | | | |

**Table 2 cont.** Observation intervals, methods and contents of studies, and use of standardized instruments. Publications sorted by main population group investigated in study and by descending frequency of the standardized instruments used. Only instruments that have been used in at least two publications are shown

| Author | Intervals of observation after disaster | Methods (contents) | Most frequently used standardized instruments | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | IES | GHQ | PTSS-10 | BDI | STAI | DSM |
| Thompson et al. | single observation at 10 months | interview | ✓ | ✓ | | | | |

IES = Impact of Event Scale; GHQ = General Health Questionnaire (28 or 30 item version); PTSS-10 = Posttraumatic Symptom Scale; BDI = Beck Depression Inventory; STAI = State-Trait Anxiety Inventory; DSM = Diagnostic and Statistical Manual of Mental Disorders (DSM-3 or DSM-4)
* = Herald of Free Enterprise disaster; ** = MS Estonia disaster

therefore not displayed in Table 2), so that in total 16 different standardized instruments were used.

A sufficient analysis of the PTSS-10 was not possible due to a lack of clear information and uncertainty about the versions of the score used, the ranges employed and the cut-off values. Consequently, this score is not evaluated and further taken into account in the present review. Furthermore, a comparison of STAI scores was not a meaningful addition to this review and was also omitted from the analysis because Dalgleish et al. (2000) [20] did not provide separate values for the subscales (State and Trait Anxiety).

Other prominent methods used to collect information on symptoms included the use of non-standardized or open questions (8/12), the extraction of information from documents (5/12), the gathering of information through interviews (4/12), and the observation of subjects and diagnosis of mental disorders during care (3/12), as shown in Table 2. The earliest observations were made immediately after the disaster and the latest observations were made an average of eight years after the disaster. Three studies employed single observations, five studies collected observations over continuous periods of varying intervals and four studies conducted multiple observations at specific times. A brief narrative summary and description of the observation intervals after the maritime disaster can be found in Table 2.

While post-disaster interventions, either by external parties (e.g. social services, government agencies) or by health professionals, were mentioned in seven studies [16, 18, 19, 22, 23, 25, 27], only three [16, 22, 25] provided detailed descriptions. Among these, merely Dyregrov and Gjestad (2003) [22] analyzed possible effects of the intervention; they found no significant difference in IES-Total or GHQ values between participants and non-participants of applied debriefing sessions.

Table 4 presents data from the IES-Total, BDI and GHQ instruments, as only these scores provided sufficient analyzable data in at least two studies. The IES-Total is used as a measure of posttraumatic stress symptoms, the BDI as an assessment of depressive symptoms and the GHQ as a screening tool for psychiatric illness [10–12].

In almost all of the included studies, regardless of group affiliation (merchant seafarers, navy crew/US Coast Guard members or passengers) or observation period, the mean values of IES-Total are well above 10 (as reference value of a normal population sample) [12, 26, 28]. Furthermore, the disaster studies on passenger vessels [20, 27, 26] report mean IES-Total values that considerably surpass the 35-point cut-off level proposed by Neal et al. (1994) [29] at the initial observation. While IES-Total values generally significantly decrease over time in the studies with multiple observation periods (except for Joseph et al. (1991) [24]), significant long-term posttraumatic stress symptoms can be observed, as the mean IES-Total values of all included studies remained above the normal population reference value of 10. In fact, the passenger studies by Dalgleish et al. (2000) [20], Joseph et al. (1991) [24] and Thompson et al. (1994) [26] show that even after three years, 19 months and ten months respectively, the mean values of IES-Total score are still above the cut-off value of 35.

Different levels of depression severity can be distinguished based on the version of the BDI used in the studies (a value between ten and 20 is suggested to be associated with mild depression, while values between 20 and 30 are indicative of moderate depression and values above 30 are reflective of severe depression) [30]: At the earliest observation period measured, the mean BDI values in the study by Joseph et al. (1991) [24] are in the range for moderate depression at eight months after disaster, while the mean values reported by Dalgleish et al. (2000) [20] fall within the threshold for mild depression at twelve months after disaster. Over time, both passenger studies show a reduction in depressive symptoms, yet both remain at moderate and mild depression levels, respectively, even at several years after the disaster.

**Table 3.** Victims of disaster and investigated survivor populations. Publications sorted by main population group investigated in study (study group)

| Author | Disaster | | | Characteristics of investigated survivors | | |
|---|---|---|---|---|---|---|
| | **Study group** | **Total number of persons aboard ship** | **Total fatalities (%)** | **Description/recruitment of population** | **n** | **Age** |
| Líndal & Stefánsson | seafarers | not specified | not specified | – case group: 5 fishermen crews which were involved in fatal disasters<br>– control group: 15 fishermen crews which were involved in non-fatal disasters | – case group: 24<br>– control group: 88 | mean 39.4 ± 9.1 years |
| Tekin et al. | seafarers | not specified | 6 | burn patients after boiler room steam explosion | 9 | mean 27 years (range 23-53) |
| McCaughey | seafarers & navy crew | 29 | 11 (38%) | all survivors | – 7 seafarers<br>– 11 navy crew members | – seafarers: mean 25.3 years<br>– navy crew: mean 26.7 years |
| Eid et al. | navy crew | 114 | 1 (0.9%) | survivors of disaster who were available on ship 3 weeks after disaster | – first questionnaire: 82<br>– second questionnaire: 74<br>– third questionnaire: 64 | – officers: mean 29.8 years (SD 5.5)<br>– crew: mean 21.6 years (SD 1.7) |
| Hoiberg & McCaughey | navy crew | 336 | 7 (2%) | – cohort group: surviving crew of disaster group<br>– control group: crew of comparable ship | – cohort group: 329<br>– control group: 387 | not available |
| Dalgleish et al. * | passengers | < 580 | 193 (≥ 33%) | – first observation: survivors referred to psychology department, often in regard to compensation claims<br>– second & third observation: survivors known to social services<br>– control group: matched subjects | – first observation: 37<br>– second observation: 73<br>– third observation: 37<br>– control group | – first observation: mean 33 years (range 16–63)<br>– second observation: mean 35 years (range 17–55)<br>– third observation: mean 39.8 years |
| Dooley & Gunn * | passengers | 459 | 193 (42%) | survivors referred for psychiatric evaluation and assessment of psychological injuries in regard to compensation claims | 47 | 15/75 (20%) < 20 years |

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**Table 3 cont.** Victims of disaster and investigated survivor populations. Publications sorted by main population group investigated in study (study group)

| Author | Disaster | | | Characteristics of investigated survivors | | |
|---|---|---|---|---|---|---|
| | Study group | Total number of persons aboard ship | Total fatalities (%) | Description/recruitment of population | n | Age |
| Joseph et al. * | passengers | 600 | 193 (32%) | survivors of disaster who were assessed by psychology department, provided a written statement about their experiences and sought out financial compensation | 20 | mean 34 years (range 19–54) |
| Dyregrov & Gjestad | passengers | 85 | 16 (19%) | contactable survivors | – first questionnaire: 53<br>– second questionnaire: 29 | mean 27.9 years (SD 12.0, range 14–62) |
| Eriksson & Lundin ** | passengers | > 900 | ~765 (~85%) | Swedish survivors of disaster | 42 | mean 40.5 years (range 19–65) |
| Taiminen & Tuominen ** | passengers | > 1,038 | > 900 (~87%) | survivors taken to Turku University Central Hospital | 38 | mean 34.8 years (range 12–77) |
| Thompson et al. | passengers | 131 | 51 (39%) | survivors referred by solicitors | 27 | mean 27.9 years (SD 4.9) |

* = Herald of Free Enterprise disaster; ** = MS Estonia disaster

While the included studies use different versions of the questionnaire, namely GHQ-28 and GHQ-30, the proposed cut-off levels for the screening of psychiatric conditions by the original authors are similar at 4/5 and 3/4, respectively [11, 31]. At the initial assessment, the mean GHQ values are distinctly above the cut-off score and thereafter show a decrease in values over time. Two notable exceptions are observed, as Joseph et al. (1991) [24] reported an increase in mean GHQ scores between eight and 19 months, and Dyregrov and Gjestad (2003) [22] reported a mean GHQ value below the cut-off of 4/5 (GHQ-28) at 18 months.

## DISCUSSION

Survivors of a maritime disaster are potentially exposed to an exceptionally high level of psychomental distress. It is therefore of great importance to gain an understanding of the manifestation of post-disaster symptoms. Post-traumatic stress disorder, depression and anxiety are common psychopathological manifestations in the aftermath of disasters [8, 13]. The aims of the included studies focused primarily on the assessment of the short-term effects of the disaster on survivors, although long-term effects were also frequently investigated. Some of the studies were also intended to examine the impact of certain disaster characteristics or other possible influences on symptom severity, although these factors are not the subject of this review. The most frequently identified instruments in the review to investigate the short- and long-term mental health effects of a maritime disaster include the IES, BDI and GHQ.

The IES was developed as an instrument to evaluate posttraumatic stress symptoms following a traumatic or stressful event and consists of a series of 15 items from the symptom clusters intrusion and avoidance [12, 28]. The IES-Total score has been established as one of the most widely used instruments for measuring PTSD symptoms in disaster research, exhibits high sensitivity and specificity (89% and 88% at a cut-off value of 35), and has been substantiated and psychometrically validated as a screening instrument for PTSD in further research [8, 29, 32, 33]. In addition, Dyregrov and Gjestad (2003) [22] reported a Cronbach's alpha coefficient for IES-Total of 0.89 and Eid et al. (1999, 2001) [28, 18] reported a Cronbach's alpha of 0.85 for IES-Total, reflecting a high degree of internal consistency.

The analysis of the IES-Total values of the investigated populations indicates that individuals, regardless of their group affiliation, manifest pronounced intrusion and avoidance symptoms after a maritime disaster. The reduction in posttraumatic stress symptoms over time in survivors of maritime disasters is largely consistent with the observation of the review by Newnham et al. (2022) [8], who evaluated the prevalence and time course of PTSD symptoms

**Table 4.** Scores of the most frequently used standardized instruments with at least one inter-study comparison. Publications sorted by main population group

| Author | Time after disaster | Mean values of the most frequently used standardized instruments | | |
|---|---|---|---|---|
| | | IES-Total | BDI | GHQ |
| Líndal & Stefánsson | avg. of 8 years | 18.4 | | |
| Eid et al. | 3 weeks | 22.5 | | |
| | 4 months | 13.8 | | |
| | 12 months | 14.2 | | |
| Dalgleish et al. * | within 1 year | 44.2 | 17.9 | 21.9 |
| | 3 years | 35.1 | | 10.0 |
| | 6 years | 27.0 | 13.1 | |
| Joseph et al. * | ~7.5 months | 46.9 | 29.4 | 22.4 |
| | ~19 months | 44.8 | 24.4 | 25.7 |
| Dyregrov & Gjestad | 6 weeks | 26.6 | | 7.0 |
| | 18 months | 19.1 | | 4.0 |
| Eriksson & Lundin ** | 3 months | 28.3 | | |
| Thompson et al. | 10 months | 46.4 | | 15.4 |

* = Herald of Free Enterprise disaster; ** = MS Estonia disaster

across diverse land-based disaster types. The mean IES-Total value in some of investigated populations even exceeds the cut-off score of 35 after several months and years, indicating the likely occurrence of a PTSD diagnosis [22, 29]. This suggests that maritime disasters have the potential to cause considerable long-term posttraumatic stress symptoms.

The findings of the seafarer study by Líndal and Stefánsson (2011) [15] support the assumption that the above findings also apply to merchant seafarers. Although the first assessment of posttraumatic stress symptoms using the IES-Total did not take place until eight years after the disaster, the relatively high symptom burden and the observed general decrease in symptoms indicate a substantial initial manifestation of posttraumatic stress symptoms. This assumption is partly supported by the authors of the study, who also hypothesized a significant burden of posttraumatic stress symptoms after the seafaring disaster [15].

The BDI is a 21-item inventory that rates the intensity of attitudes and symptoms commonly seen in depressed patients on a scale from 0 to 3 [10]. The small decline in mean BDI values between 8–12 months and several years after the disaster suggests that depressive symptoms among survivors of maritime disasters remain elevated and decline only slowly, at least for the period beyond one year. This is consistent with the findings of the aforementioned review of land-based disasters, which also found an elevated prevalence of depressive symptoms following disaster exposure that remained relatively stable over time, particularly within the first two years [8].

The GHQ differs from the previously discussed instruments as it is not designed to measure specific psychological symptoms, but rather as a screening instrument to identify individuals who exhibit symptoms of psychiatric conditions [11]. The questionnaire includes a wide spectrum of items which are rated according to their severity; for example, the GHQ-28 version includes somatic, social, psychological, and psychiatric symptoms [11]. The cut-off values used to screen for psychiatric disorders of 4/5 for the GHQ-28 (sensitivity 88% and specificity 84%) and 3/4 for the GHQ-30 (sensitivity 85% and specificity 80%) demonstrate satisfactory diagnostic performance [11, 31]. One study [22] has demonstrated a high degree of internal consistency of the GHQ based on a Cronbach's alpha coefficient of 0.93. The mean GHQ values of the passenger populations were almost exclusively distinctly above the cut-off level, suggesting a high burden of various somatic, psychological and psychiatric symptoms after maritime disaster. The time course of symptoms as measured by the GHQ demonstrates a more heterogeneous pattern than those observed for the IES and BDI scores discussed previously. Nevertheless, the results support the conclusion that significant symptoms may persist for an extended period of time.

Finally, it's worth noting that the items of the GHQ correspond to some of the symptoms of the standardized scores discussed earlier, as well as to some of the symptoms that were summarized in the section "Symptoms of survivors after maritime disaster". For instance, anxiety-related symptoms are prominently featured in the GHQ items [11], and Taiminen and Tuominen (1996) [25] and Dooley and Gunn (1995) [27] have observed symptoms of the anxiety cluster in the majority of survivors or have frequently diagnosed anxiety disorders among their survivor populations. These exploratory findings suggest that anxiety may have a substantial impact on the mental health and well-being of survivors in the aftermath of a maritime disaster.

## METHODS AND OBJECTIVES FOR FUTURE MARITIME RESEARCH

Future researchers have to select appropriate instruments to assess the mental health of survivors of maritime disasters. Depending on whether the chosen focus of the study is to assess posttraumatic stress or depressive symptoms or to screen for psychiatric disorders, the IES, BDI and GHQ scores appear to be interesting instruments for future maritime disaster research. They exhibit promising psychometric properties for use as screening instruments [11, 12, 31–33] and because of their previous use in maritime disaster studies, future researchers can draw on reference populations when evaluating and comparing results. This is particularly important because, as this review demonstrates, studies of maritime disasters are relatively rare and many aspects of maritime disasters remain insufficiently understood.

While this systematic review provides information on post-disaster mental health reactions, it does not provide much insight into how best to support survivors of maritime disasters. Only Dyregrov and Gjestad (2003) [22] have investigated the effects of an intervention on mental health after the experience of a maritime disaster. However, they found no evidence that the debriefing of survivors after a maritime disaster results in a significant reduction in posttraumatic symptoms [22]. Further research into the effectiveness of interventions for survivors of maritime disasters is urgently needed to improve the psychological care of disaster victims and to establish evidence-based interventions.

## LIMITATIONS

There are some limitations to this review that should be considered. A main limitation is that there are relatively few studies of merchant seafarers in this review, as only three of the twelve studies (comprising 40 seafarers) focused

on them. While the original intention of this review was to evaluate the post-disaster psychomental reactions of merchant seafarers, maritime disaster studies involving navy crew/US Coast Guard members and passengers were also included due to the small number of studies that addressed merchant seafarers. Although the last exclusion criterion applied (conceivable scenarios in merchant shipping) was introduced explicitly to make comparisons between populations as meaningful as possible, and indeed many parallels in symptom presentation were found particularly between passengers and merchant seafarers, it remains a significant limitation.

The included studies also varied considerably in terms of the investigated populations, methods, study aims and the magnitude of the disaster. There were also uncertainties and discrepancies in the reported figures, such as the number of individuals on board and the number of fatalities in the same disaster (Table 3), or imprecise information on the observation intervals (Table 2). Finally, it should be noted that it is not possible to fully and comprehensively capture the circumstances or trauma potential of the disaster and other influencing factors from the review of studies. As a result, potential influences on the mental health of survivors after a disaster may have gone unrecognized.

## CONCLUSIONS

The findings from the review affirm some of the results of general, land-based disaster research; this suggests that the review was able to validate certain aspects in the context of maritime disasters. The summarized evidence supports that even many years after a maritime disaster, a significant burden of psychological symptoms, particularly posttraumatic stress symptoms and depressive symptoms, can be present and affect the mental health of survivors. This systematic review provides a descriptive overview of reported psychomental symptoms after fatal maritime disasters. The consideration of the results and findings of the review could provide an important basis for the identification of survivors' mental health needs and the development of more effective interventions for seafarers and other victims of maritime disasters.

## ARTICLE INFORMATION AND DECLARATIONS

**Author contributions:** Author — conception and execution of review, literature search, interpretation of results, discussion, writing. Co-authors — conception of review design, supervision, assistance in writing and interpretation /discussion.

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# MAGAZINE
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# Editorial

**by James A. Denham**

Dear Readers,

It is with great pleasure that I welcome you to this year's second issue of the International Maritime Health Magazine. As we continue our journey through a dynamic and ever-changing maritime landscape, this issue aims to bring together timely insights, professional experiences, and emerging concerns that reflect the pulse of maritime health today.

We all know that the maritime world does not exist in isolation – it sails through the tides of global change. In this edition's editorial, I invite you to reflect on how broader political and economic shifts can influence the well-being of those at the heart of the industry: our seafarers. From rising stress levels linked to uncertain working conditions to the complex realities of abandoned vessels, these challenges remind us that the health of the maritime workforce is closely tied to decisions made far beyond the docks.

I hope the content within these pages informs, inspires, and encourages continued dialogue across our global community.

Warm regards,
James A. Denham, MD
Editor, IMH Magazine

## CAUGHT IN THE CONFLICT: THE HUMAN TOLL OF GLOBAL POLITICS ON SEAFARERS

**by James A. Denham**

As geopolitical tensions, rising protectionism, the shifting of global alliances, and economic pressures mount worldwide, the maritime workforce finds itself increasingly at risk-physically, emotionally, and financially. This often makes seafarers an invisible front-line workforce that must withstand the consequences of these challenges.

Recent events in the Black Sea, the Sea of Azov, and the Red Sea have not only disrupted shipping routes but have also severely compromised seafarers' sense of safety[1, 2]. Crews navigating in these high-risk areas face increased levels of stress, anxiety, and trauma, often with little surety of protection or adequate support.

Photographer: Gimeil O. Abuda. Title: Stranded Fleet. Credit: Image sourced from the ITF Seafarers' Trust's digital photo gallery www.lifeatsea.co.uk

Mental health experts have expressed concern about the psychological toll on seafarers operating in these perilous areas. For **maritime physicians**, these events translate into a growing number of seafarers suffering from stress-related disorders such as **depression, anxiety, PTSD, and sleep disturbances.** Reports from organizations like ISWAN and the Seafarers' Hospital Society support this trend, highlighting the rising reports during port health visits after prolonged political or legal disruptions[3]. The isolation inherent in maritime work exacerbates these issues, underscoring the urgent need for comprehensive mental health support.

*"When politics enters the ship, the seafarers will unfortunately end up paying part of the toll."*

A parallel crisis is quietly unfolding: a significant increase in crew abandonment. New data from the International Transport Workers' Federation (ITF) shows that the number of seafarers abandoned by shipowners is expected to increase by 87% by 2024 compared to last year. The situation has become alarming, with the number almost doubling — 3,133 seafarers abandoned in 2024 compared to 1,676 in 2023, leaving them without wages, resources or the means to return home. A total of 312 ships were abandoned last year compared to 132 ships in 2023 — a staggering increase of 136%[4]. Twenty-eight ships were also responsible for abandoning multiple crews in the same year, with three ships reported for abandoning crews three times and 25 ships reported for abandoning crews twice.

Abandoned seafarers may experience months of unpaid wages, extremely poor conditions on board, inadequate food and clean drinking water, and long hours of work without adequate rest. In some cases, they are left completely stranded for months or even years.

The lack of enforcement and responsiveness by flag and port states, together with the lack of insurance for ships and the refusal of shipowners to acknowledge the mistreatment of their crews, are common factors that contribute to abandonment and make it difficult to resolve cases. These abandoned crews are often victims of failing companies or flag states in legal or financial turmoil — essentially collateral damage resulting from larger political and economic decisions. Many ships in these abandonment cases sail under flags of convenience (FOCs) such as those of Panama, Liberia and the Marshall Islands. These registries often offer looser regulations, lower taxes and fewer labour protections, making them attractive to shipowners but dangerous for seafarers.

The Panama Maritime Authority (AMP) recently deregistered 107 vessels, with an additional 18 under review due to alleged links to illicit activities, such as sanctions violations, smuggling, or suspicious ownership structures[5]. This move appears to be a response to international pressure, particularly from the US and European authorities, to increase transparency and crack down on the misuse of the registry.

Here's where the two issues converge:

1. Flag states under pressure may begin purging questionable vessels without strong mechanisms to protect the crew, causing seafarers to become stranded-sometimes left unpaid and without repatriation options when a vessel is suddenly deregistered.
2. Companies operating on thin margins or through shell corporations may abandon ships when they are blacklisted or deregistered, either to avoid penalties or because their operational chain collapses.
3. Political and regulatory crackdowns, while necessary, sometimes lack humanitarian foresight — leading to unintended consequences for seafarers on board.

While the Panama Maritime Authority's recent decision to cancel vessel registrations reflects a necessary action against irregular shipping activity, such measures can inadvertently leave seafarers aboard the vessels in limbo, abandoned on vessels that are no longer recognized under any flag, with no legal framework to ensure their welfare.

Together, these issues reveal an uncomfortable truth: global policies and political instability directly shape the health and dignity of those who keep the world's trade afloat. While cargo reroutes and insurance premiums dominate headlines, the human cost — the stress, uncertainty, and long-term psychological impact on seafarers — receives far less attention.

As maritime professionals and advocates, we must ensure that seafarers are not "the forgotten casualties of international policy". Their safety and well-being must remain central in discussions about global trade, maritime regulation, and port-state responsibilities.

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# News

**contributed by Nebojša Nikolić**

## FROM WHO

Seventy-eighth World Health Assembly concludes: historic outcomes, with sequential highlights The Seventy-eighth World Health Assembly (WHA78), the annual meeting of the World Health Organization's (WHO) Member States, and WHO's highest decision-making body, convened from 19 May to 27 May, under the theme "One World for Health". Member States considered approximately 75 items and sub-items across all areas of health, engaging in lively debate and adopting consequential resolutions to improve health for all. Among, them on 20 May, Member States adopted the historic WHO Pandemic Agreement. The adoption of the Agreement is a once-in-a-generation opportunity to safeguard the world from a repeat of the suffering caused by the COVID-19 pandemic. The Agreement aims to enhance global coordination and cooperation, equity and access for future pandemics, all while respecting national sovereignty.

Over the next year, Member States will build on the Resolution by holding consultations on the Pathogen Access and Benefit Sharing system (PABS), an annex to the Agreement, which would enhance equitable access to medical advancements.

The World Health Assembly also discussed WHO's work in health emergencies. Over the last year, WHO responded internationally to 51 graded emergencies across 89 countries and territories, including global outbreaks of cholera and mpox — a public health emergency of international concern — as well as multiple humanitarian crises. Working with over 900 partners across 28 health clusters, WHO helped provide health assistance for 72 million people in humanitarian settings. Nearly 60% of new emergencies were climate-related, highlighting the growing health impacts of climate change.

## FROM ILO

A new joint study from the International Labour Organization (ILO) and Poland's National Research Institute (NASK) finds that 1 in 4 jobs worldwide is potentially exposed to generative artificial intelligence (GenAI) — but that transformation, not replacement, is the most likely outcome.

The report, launched on 20 May, introduces the most detailed global assessment to date of how GenAI may reshape the world of work. The index provides a unique and nuanced snapshot of how AI could transform occupations and employment across countries, by combining nearly 30,000 occupational tasks with expert validation, AI-assisted scoring, and ILO-harmonized microdata.

Twenty-five per cent of global employment falls within occupations potentially exposed to GenAI, with higher shares in high-income countries (34 per cent).

Clerical jobs face the highest exposure of all, due to GenAI's theoretical ability to automate many of their tasks. However, the expanding abilities of GenAI have resulted in an increased exposure of some highly digitized cognitive jobs in media-, software- and finance-related occupations.

Full job automation, however, remains limited, since many tasks, though done more efficiently, continue to require human involvement. The study highlights the possibly divergent paths for occupations accustomed to rapid digital transformations — such as software developers — and those where limited digital skills might have more negative effects.

Policies guiding digital transitions will be a leading factor in determining the extent to which workers may be retained in occupations that are transforming as a result of AI, and how such transformation affects job quality.
The ILO–NASK study emphasizes that the figures reflect potential exposure, not actual job losses. Technological constraints, infrastructure gaps, and skills shortages mean that implementation will differ widely by country and sector. Crucially, the authors stress that GenAI's effect is more likely to transform jobs than eliminate them.
The report calls on governments, employers', and workers' organizations to engage in social dialogue and shape proactive, inclusive strategies that can enhance productivity and job quality, especially in exposed sectors.

## FROM IMO

### IMO TO DEVELOP GLOBAL STRATEGY FOR MARITIME DIGITALIZATION

The International Maritime Organization (IMO) is taking action to create a comprehensive strategy that harnesses emerging technologies to turbo-charge efficiency, safety and sustainability in the shipping industry.
The cross-cutting strategy will span different areas of IMO's work, fostering a fully interconnected, harmonized and automated global maritime sector.
To guide this process, the Facilitation Committee established a Correspondence Group to define the strategy's scope, key objectives and implementation framework. The Group will work over the coming year to identify existing and emerging technologies, standards and methodologies that can support maritime digitalization, while ensuring alignment across IMO's various committees.
IMO Secretary-General Arsenio Dominguez emphasized the transformative potential of cutting-edge technologies such as AI and autonomous navigation, while recognizing related challenges, including cybersecurity risks and the global digital divide.
He stated: "The IMO Maritime Digitalization Strategy is a game-changing effort to make smooth, seamless, smart shipping a reality. It will help integrate vessels and ports, improve logistics and optimize routes, while reducing greenhouse gas emissions. We must work together to ensure the strategy serves all."
The strategy builds on previous milestones, including the introduction of mandatory Maritime Single Window (MSW) regulations last year, which require ships and ports to use a single digital platform to exchange information and streamline port call procedures.
The success of the IMO digitalization strategy will depend on input from Member States and international organizations, particularly concerning safety and environmental protection considerations.

## FROM ITF

### WELLBEING DIRECTORY — ITF'S HELP SERVICE FOR SEAFARERS

Wellbeing is the experience of health, happiness and life satisfaction and not just the absence of disease or illness. It includes good mental health, a sense of meaning or purpose in life, and the ability to manage stress. The relationship between health and wellbeing is not just one-way — health influences wellbeing and wellbeing itself influences health.
Whether a seafarer wants to know more or is concerned about himself or a loved one, the ITF's Wellbeing page can help. It has detailed information about organisations that offer confidential expert advice on mental health issues through phone calls, emails and social media platforms.
https://www.itfseafarers.org/en/directories/wellbeing-directory

## FROM LLOYD'S REGISTER

Lloyd's Register's Global Maritime Trends 2025 Barometer warns that fragmented regulation is undermining progress in decarbonisation and limiting investment.
The global shipping industry risks falling short of its net-zero and digital transformation ambitions without sufficient regulatory support enacted at a global level, according to the inaugural Global Maritime Trends 2025 Barometer by Lloyd's Register (LR) and Lloyd's Register Foundation.
The Barometer presents a first-of-its-kind data-driven assessment of the maritime industry's energy and digital transition progress across five key components: maritime trade, energy, vessels, ports, and people.
Its findings reveal that, despite promising developments in alternative fuel technologies and digital innovations, widespread adoption of green fuels is unlikely without robust and coordinated regulation.

The report highlights that regulatory uncertainty is deterring shipowners from making the necessary long-term investments, resulting in a "delayed transition" that threatens to derail decarbonisation targets and digital parity with land-based industries. Regulatory mechanisms such as carbon pricing, emissions mandates, and incentives for green investments will be essential to accelerate adoption worldwide.

Despite the orderbook for alternative-fuelled ships growing by over 50% in 2024, the 2025 Barometer reveals that global energy production remains heavily reliant on fossil fuels. Energy transition scores ranged from just 24% to 30% alignment with decarbonisation targets.

On the digital front, the maritime industry is making progress (32–48% alignment) but still lags behind land-based industries. The Digital Transition Barometer includes data derived from LR's Digital Maturity Index and identifies data standardisation, interoperability, widespread lack of digital skills among seafarers and shore-based teams as major barriers to progress.

One of the report's most concerning findings is the critical gaps in workforce development, impacting both transitions — the People component scored only 27% alignment on energy transition and 32% alignment on digital transition. Training programmes remain insufficient to prepare seafarers for safely operating vessels powered by alternative fuels and implementing new digital technologies. Recruitment struggles persist because of an ageing workforce and declining interest in maritime careers.

### FROM THE SEAFARERS' CHARITY

The Seafarers' Charity is partnering with NeurodiversAtSea and the Seafarers Hospital Society on a new initiative to provide tailored support for neurodivergent seafarers — including access to formal diagnostic assessments through a pilot grant scheme.

The project builds upon research conducted by NeurodiversAtSea which identified a lack of industry support for neurodivergent seafarers, with just two out of 118 survey respondents reporting their employer provided any form of assistance to access formal assessments or diagnosis.

Additionally, 62% of respondents reported no specific assistance for neurodivergent employees. The key finding of the research was the urgency and scale of the issue, because while seafarers recognise the upsides of diversity in the industry, neurodivergent people still face significant discrimination and career harm.

By making £9,761 available to UK-based seafarers as part of an initial pilot scheme, this project aims to provide grant funding for seafarers who suspect they're neurodivergent so they can pursue a formal diagnosis, enabling them to access reasonable adjustments for exams and from their employer.

With up to 15% of the UK population being neurodivergent, including an estimated 1.2 million autistic individuals and 2.2 million with ADHD, alongside other conditions such as dyslexia, dyspraxia and dyscalculia, this project takes a step towards unlocking an underutilised talent pool for the maritime sector within the UK.

## Communication

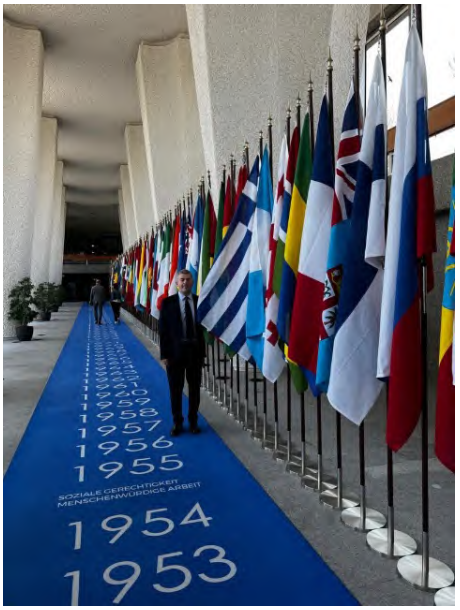
### IMHA PARTICIPATES IN KEY MLC 2006 MEETING AT THE ILO IN GENEVA

IMHA was honoured to participate — by invitation — in the fifth meeting of the ILO Special Tripartite Committee, convened under Article XIII of the Maritime Labour Convention (MLC), 2006, as amended. The event took place from April 7–11 in Geneva and brought together over 400 delegates representing governments, shipowners, and seafarers.

As an accredited observer at the ILO, IMHA was one of the few NGOs present, alongside respected organizations such as the Seafarers Trust, ICMA, ISWAN, and Seafarers' Rights International (SRI).

The meeting focused on reviewing sixteen proposed amendments to the MLC. These were carefully examined and debated by government representatives and social partners, working toward consensus on key revisions that will shape future protections for seafarers.

A significant highlight was the presentation by the ILO's statistics office of the first-ever Global Register of Fatalities at Sea: Experimental Data Collection. This preliminary report marks a crucial step toward understanding patterns of seafarer mortality — a subject of great relevance to our maritime health community.


Photographer: Nicholas Ioannidis. Credit: Image sourced from IMHA LinkedIn feed at https://www.linkedin.com/feed/update/activity:7318946947141136384

Both the finalized amendments and the preliminary report on fatalities at sea are available in the Members section of the IMHA website. A comprehensive summary will also be featured in the upcoming IMHA members' newsletter.
For information on access to these resources, please contact: office@imha.net.

## IMHF PRESENTS AT CESMA'S ANNUAL GENERAL ASSEMBLY

Bill Kavanagh, Chair of the Expert Panel (EP) of the International Maritime Health Foundation (IMHF), delivered a presentation at the Annual General Council Meeting and General Assembly of the **Confederation of European Shipmasters' Associations** (**CESMA**), held in Lisbon on 14–15 May 2025. The Council meeting took place at SINCOMAR — the Union of Captains and Officers in Portugal — while the Assembly was hosted at the European Maritime Safety Agency (EMSA).


Credit: Image provided by Bill Kavanagh, IMHF

Founded in 1995, CESMA represents shipmasters from 16 European countries and holds consultative status with the European Commission. Its annual resolutions are submitted to the Commission, influencing maritime policy at the European level. This year's topics included the safety of navigation in the Red Sea, visa barriers limiting crew mobility, the transportation risks of lithium-ion batteries and electric vehicles, support for seafarer education, container transport safety, harmonisation of port administration, and the urgent need to address the criminalisation of shipmasters — including access to legal support. Notably, aside from mental health, medical, telemedicine, and maritime health topics have been underrepresented in recent discussions.

The IMHF presentation outlined the Foundation's core aims and objectives, highlighting the publication of the International Maritime Health Journal and its relevance to both clinical and operational maritime stakeholders. Online resources were shared, and particular attention was given to the EP's ongoing work on updating medical training requirements under the STCW Code. Delegates were encouraged to engage with their respective member associations and contribute suggestions for this important initiative. The presentation is now available to CESMA members via the association's website (www.cesma-europe.org).

Several key issues emerged during informal exchanges throughout the event. One recurring concern was the proposal to implement routine medical drills on board, which was met with hesitation. Shipmasters noted that administrative burdens have significantly increased, leaving little time for additional responsibilities. The compounding effects of continuous audits, inspections, and oversight from shore offices were cited as major contributors to fatigue and reduced well-being. Moreover, shore leave opportunities are increasingly rare, as in-port demands consume crew rest time. Delegates agreed that commercial pressure and excessive administrative demands are among the primary stressors for today's seafarers, potentially compromising both safety and mental health.

IMHF expresses its sincere thanks to Capt. Dimitar Dimitrov, PhD, President of CESMA, for including the IMHF presentation in the programme and for encouraging deeper collaboration between maritime medicine and the seafaring community.

# Particulars

In preceding magazines, we presented to you the people who have taken or changed positions in our foundation's structures. This time we would like to introduce a new section:

## DOCKSIDE DIALOGUES: A CHAT WITH MARITIME HEALTH EXPERTS

**An interview with Dr. Rimsky Sucre**

In the world of maritime medicine, a few voices stand out for their ethical clarity, lived experience, and civic leadership. One such voice is that of Dr. Rimsky Sucre — a Panamanian physician, activist, and founder of Clínica Einstein. Dr. Sucre is not only a respected medical professional, but also a man who witnessed history. As a teenager, he was present during one of the most pivotal moments in Panamanian history. That day, marked by sacrifice and pride, helped shape his lifelong commitment to health, justice, and public service.

In this inaugural edition of **Dockside Dialogues**, Dr. Sucre reflects on the formative events of his youth, his journey in medicine, and the challenges and rewards of working at the intersection of healthcare and maritime labour.

***"Our studies and our work are sacred — they center on the human body and life itself."*** — **Dr. Rimsky Sucre**

**1. You've described yourself as a privileged man because you had the chance to live in diverse and enriching neighborhoods of Panama City. How did these experiences shape your worldview and commitment to social justice?**

I've often spoken about my early experiences in Panama, which, despite being a small city, was a place where people largely knew each other and maintained healthy relationships. As children, we roamed freely in a city marked more by classism than racism. I was blessed with parents who were ahead of their time — open-minded, engaged with national and global

issues, and unafraid to express and defend their values. They raised me with strong principles and a sense of responsibility to serve the greater good. All of this helped shape the person I am today.

**2. January 9, 1964, was a tragic and pivotal day for your country. As a student at the Instituto Nacional, what memories stand out – and how did that experience influence your path toward medicine?**
That day left a lasting impact. I carried the first wounded person after American troops opened fire. At Santo Tomás Hospital, we alerted doctors that many more injured were on the way — the sound of gunfire told us that. The emergency room became a 'war hospital' for the first time, and all the doctors and nurses, especially those from the Hospital del Niño, mobilized heroically. A few days later, my parents urged me to leave the country, and I chose Brazil. I had already faced several illnesses in childhood, but that moment – witnessing trauma firsthand — confirmed that medicine was my calling.

**3. You founded Clínica Einstein in 1972. What inspired its creation, and how has its mission evolved over time?**
Planning and renovations began in 1971. A couple of years later, maritime agencies — many operating since the opening of the Panama Canal — approached us. With the gradual reduction of services at Gorgas Hospital, there was a clear need for dedicated medical care for seafarers. That prompted us to develop our services. Participating in Maritime Medicine Symposiums and joining IMHA (International Maritime Health Association) also played a key role — they were both sources of immense professional support and inspiration. I met many "Dr. Sucre's" there — doctors who shared the same passion and commitment.

**4. What challenges have you faced in the field of maritime health?**
It hasn't been easy. The field has demanded constant creativity, problem-solving, and continuous learning. Since my first navigation experience at the Panama Canal in 1971, I've seen maritime health evolve, largely due to the tireless efforts of organizations like WHO, ILO, ITF, and STCW — and of course, the dedication of maritime physicians worldwide. But there's still work to be done. I'm particularly concerned about the lack of effective and realistic social security systems for the global merchant navy. It's a complex issue we must keep working on.

**5. Looking back, which accomplishments in your medical and civic life bring you the greatest pride?**
There are many moments I hold close. During my second year of medical school, I organized a rescue center in Botafogo during severe floods. We treated numerous injured people, and though I missed the ceremony at Maracanã Stadium where we were honored, it remains a proud memory. I also contributed to drafting the Code of Ethics for the Medical Association of Panama and the Preliminary Draft for Medical Registration, as part of the Association's Legal and Trade Union Affairs Committee. Those contributions meant a lot to me, as they addressed both professional integrity and public accountability.

**6. What advice would you offer young professionals who want to make a difference in both healthcare and society?**
Use technology — AI, databases, automation — but don't become overly dependent on it. Return to the physiological roots of medicine. Let ethics and respect for life guide your work, not profit or marketing. As genetics and nuclear medicine progress, never lose sight of their moral implications. In today's world, where racism, war, and intolerance are resurging, we must fight for dignity and justice. Our studies and our work are sacred — they center on the human body and life itself. Heal with purpose, conduct research, and strive for dignity. If you earn wealth, let it be the consequence of — not the goal.

**Closing reflexion**
Not many maritime physicians have combined personal history, medical integrity, and civic activism with as much grace and persistence as Dr. Rimsky Sucre. His reflections remind us that the soul of medicine lies not just in diagnostics and treatments — but in values, courage, and public service.
From the streets of Panama in the 1960s to international maritime symposiums, Dr. Sucre's voice continues to inspire those navigating the crosscurrents of health and human rights.

# Report

## MEASURING SEAFARERS HEALTH: DELEGATES GATHER IN LONDON TO DISCUSS MEASURES TO MONITOR AND IMPROVE THE WELLBEING OF MARINERS AROUND THE WORLD

**by Sandra Welch**

Over two days (27–29 April 2025), delegates from around the world headed to the Royal Foundation of St Katherine in London to attend The Performance and Quality Workshop, hosted by the Seafarers Hospital Society (SHS), the International Maritime Health Foundation and the International Maritime Health Association.

The workshop focused on quality and performance indicators for seafarer health, defined widely to include psychological health and self-perceived well-being, with the aim of bringing together several strands of thinking to develop coherent maritime management practices that enhance the health of seafarers. While cargo and related trades such as offshore support were the workshop's primary focus, it is hoped that its conclusions could help aid similar initiatives in other sectors such as passenger shipping, fishing and research vessels.

Following the comprehensive landmark report into Seafarer Health published by Yale University in August 2022, SHS developed a set of health-related Key Performance Indicators (KPIs), as published in its discussion paper, in a bid to further develop a culture of care within the maritime industry[1]. It aims to develop health-related parameters for maritime management, following the example of the KPIs established by InterManager and BIMCO[2].

[1] https://seahospital.org.uk/yale-university-report-seafarer-health-research-to-date-and-current-practice and https://seahospital.org.uk/about-us/best-practice-kpis/

[2] www.intermanager.org; https://www.shipping-kpi.org and www.bimco.org/products/bimco-ship-pi

The purpose of this workshop was to address the lack of uptake of such KPIs across the industry and to gain a better understanding of existing barriers to their full implementation. SHS has worked diligently to ensure that its KPIs have been carefully crafted to complement other commercial and regulatory regimes, and trackability and measurement are at the core of this framework, with participating organisations able to use a data-driven approach in which each factor is measured according to a four-stage scale.

The Best Practice KPI Toolkit consists of a series of simple, confidential self-assessment surveys which are divided into four incremental stages. Participating organisations will work through each level as they progressively improve and embed health and well-being measures into their corporate DNA, before reaching a level of best practice in which companies go above and beyond to implement policies that prioritise health and wellbeing.

The workshop evidenced the correlation and existing understanding of seafarer health and the impact on safety, as well as highlighting the following areas for further discussion:

1. The need, use and sharing of health data to inform, teach and effect change.
2. Current healthcare provision on board and whether it is fit for purpose.
3. Identified top health issues in seafarers.
4. Engaging with seafarers and the sector.

A report from the workshop with recommendations and future steps will be available in due course.

# CME

## NAVIGATING COMMERCE AND HEALTH IN THE MARITIME WORLD OF THE ANCIENT MAYANS

**by Dr. James A. Denham**

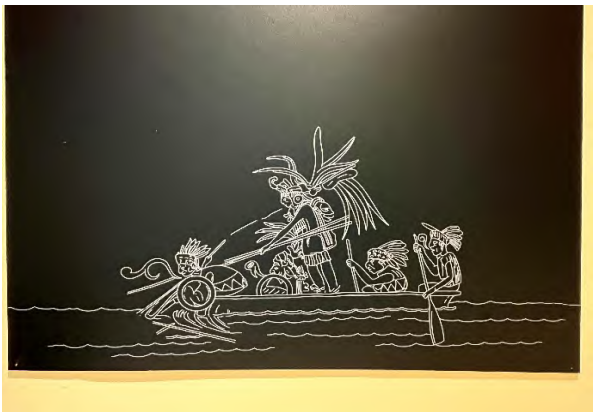
Museo Regional de Antropología de Yucatán. Credit: Image provided by James A. Denham

*"The sea does not separate us, it connects us." — An unwritten truth understood by the seafaring Maya centuries ago.*

During my recent visit to the Yucatán Peninsula, I was struck not only by the scientific and architectural brilliance of the Maya, but also by their strong relationship with the sea. While exploring the Mayan Museum, I was particularly intrigued by the extension of their maritime trade routes that once linked coastal communities across the region. As an occupational and maritime health professional, I couldn't help but consider how these ancient practices intersected with the health and well-being of those who lived and worked so close to the sea.

**A Network Across Water**

The Maya civilization, renowned for its astronomy, architecture, and mathematics, was also an advanced maritime society. Using dugout canoes they built trade routes along the coasts of the Yucatán Peninsula and beyond, to link settlements and distant regions as far east as the Miskitos region in modern-day Honduras, and to the west along the coast of Tabasco (about 1300 and 1200 coastal kilometers from Tulum respectively).



Museo Regional de Antropología de Yucatán. Credit: Image provided by James A. Denham

Unlike other ancient civilizations, the Maya did not use the wheel for transportation, nor did they have pack animals. Their primary means of moving goods was via human labor and canoe navigation — a choice that reflected both the limitations and ingenuity of their time[1]. Canoes up to 9 meters in length, sometimes equipped with small shelters to protect passengers from the elements, were used to transport salt, feathers, jade, cocoa, and other luxuries across coastal and riverine arteries.

**Maritime Work and Health: An Ancient Perspective**

The physical toll of long-distance paddling was significant. Ethnohistorical accounts and osteological studies of ancient Maya remains indicate the prevalence of repetitive strain injuries, especially in shoulders and elbows, consistent with heavy rowing[2]. Add to this the intense tropical heat, and conditions such as dehydration, heat exhaustion, and fatigue were almost certainly part of the maritime labor experience.

Mayan World Museum of Mérida. Credit: Image provided by James A. Denham

Although fishing was an important source of food, the Maya's reliance on maize-based diets during extended voyages likely made Mayan seafarers prone to some micronutrient deficiencies. Remedies were drawn from the vast pharmacopoeia of local plants, the knowledge of which was preserved and administered by *ajmen* (healers or shamans) who were not readily accessible during their travels.

**Ports as Health Gateways**

The ancient Maya had various seaports like Jaina and Tulum that played a crucial role in their trade and economy. Ports such as Nito, Naco, and those along the northern Gulf — like Dzilam and Celestún — were not just trading hubs; they also played a significant role in the political and social structures of the Maya civilization, and possibly even early forms of health stations. Archaeological findings suggest the presence of designated spaces for rest and possibly healing within larger ceremonial centers[3].


Mayan World Museum of Mérida. Credit: Image provided by James A. Denham

Salt production, a cornerstone of Yucatecan trade, also played a role in health — used in food preservation, wound treatment, and rituals of purification. Salt's dual role as both commodity and medicine is a noteworthy parallel to its use in modern-day maritime settings.

**Learning from the Past**

By viewing Mayan maritime life through a medical lens, it is clear to see an occupational profile not so different from today's seafarers, which involves physically demanding roles, exposure to environmental hazards, and the need for preventive and responsive healthcare. The Maya addressed these challenges through innovation, whether by carving shaded canoes or administering plant-based medicines, and through cultural practices that emphasized balance between body, spirit, and nature.

Modern maritime medicine continues this lineage, guided now by the sharing of data, science, technology, and a commitment to seafarers' rights and well-being. As we look toward the future of global shipping and seafaring, the resilience and ingenuity of the Maya can still teach us that now as true as it then, that health at sea will always be essential to life on land.

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# INFORMATION FOR AUTHORS

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

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

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

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

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

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

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

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

Only English texts will be accepted.

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

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

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

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

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

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

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

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

## REFERENCES

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

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

Reference to books should give the title, names of authors or of editors, publisher, place of publication, and the year.

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