

Screening for type 2 diabetes and hypertension in seafarers' medical examinations

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ABSTRACT

Background: The aims of the study are: 1) to replace the urine glucose test for diabetes with more than 50% false negatives, with an accurate screening for type 2 diabetes and hypertension in the mandatory biannual fit-for-duty medical examinations of seafarers; 2) to produce data driven “Green Ship” health promotion in the ships. A new health promotion and disease prevention public health intervention programme integrated in the fit-for-duty medical examinations for seafarers is being developed.

Materials and methods: The lack of an accurate diagnosis of type 2 diabetes is replaced by accurate HbA1c and/or fasting glucose tests and the test for hypertension in various disease stages is based on the International Associations' Guidelines. A “Green Ship” health promotion programme is proposed for all on board, not only for diseased crew members.

Results: A protocol for an accurate biannual screening for diabetes and hypertension is presented. Educational programmes for medical doctors and seafarers on the management of hypertension and diabetes on board will be developed. Presuming that all crew members are potentially on their way to be pre-diseased or are diseased, the “Green Ship” health promotion programme is implemented for the whole crew.

Conclusions: The International Labour Organization and the National Maritime Authorities are prompted to revise the International and the National Guidelines for Seafarers Medical Examinations, respectively. Coordinated actions are requested to implement public health promotion projects in shipping. Maritime medical doctors are prompted to use health dialogues and to report the clinical data in the Excel file. Sustainability is obtained by complying with the Sustainable Development Goals (3, 4, 8, 10, and 17).

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Key words: type 2 diabetes, hypertension, seafarers, fishermen, screening, early diagnosis, metabolic syndrome



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INTRODUCTION

There are over 1.6 million seafarers worldwide, with the majority originating from the Philippines, China, Indonesia, the Russian Federation, and Ukraine. Seafarers leave their homes and families to live on board as their second home, often for 9 to 12 months at a time. Today, over 50,000 merchant ships carry 90% of world trade. The people responsible for maintaining, running, and operating the fleet are seafarers. Seafarers ensure that the essential household items – televisions, laptops, clothing, etc. – are all brought to us by sea [1].

Seafarers have routine biannual fit-for-duty medical examinations based on the International Labour Organization (ILO) conventions and the Maritime Labour Convention (MLC, 2006) [2]. To ensure that medical practitioners contribute towards harmonising the standards for seafarer medical examinations, the first International Guidelines for Conducting pre-sea and Periodic Medical Fitness examinations for Seafarers was first published in 1998 and revised in 2013 [3]. Medical certificates for seafarers and fishermen have historically been issued to secure their fitness, to stay safe and healthy, to reduce risks to other crew members, and for the safe operation of their ships which are generally far away from hospitals. Seafarers, have a great inequity in health at work, with a higher risk of overweight, metabolic syndrome, type 2 diabetes and hypertension and a need for accurate early diagnosis and prevention [4–8].

While the objective 100 years ago for the fit-for-duty medical examinations was purely related to the safety of the seafarers and the ships, now the ILO guidelines inspire to include protocols related to the general health of seafarers beyond the fit-for-duty protocol. The focus on early diagnosis of type 2 diabetes and hypertension seems to be a good choice for intervention based on the evidence that pre-hypertension and pre-diabetes can be reversed by non-pharmacological and pharmacological measures [9–11]. One important problem is that urinary glucose has been widely used as a screening tool for diabetes in the fit-for-duty examinations as described in APPENDIX F in the ILO international guidelines. However, due to its low sensitivity, it cannot be recommended as a valid screening test for diabetes [12–14]. In February 2021 the International Maritime Health Association (IMHA), Europeche, and the European Transport Workers Federation (ETF) prompted The Maritime Health Research and Education-Net (Mahre-Net) to address the problems. The objective of this paper is therefore to describe how screening with accurate diagnostic tests for type 2 diabetes and hypertension can be done as an integrated part of the routine fit-for-duty health examinations for seafarers to produce valid data for personal preventive health advice, for research and for more systematic health promotion in the workplaces on board.

MATERIALS AND METHODS

STUDY DESIGN

An integrated health promotion and disease prevention program in the fit-for-duty medical examinations for seafarers together with a “Green Ship” health promotion programme is presented.

The newly-established ‘International Diabetes and Hypertension Research group in seafaring, fishing and transport workers’ consists of specialists in diabetes epidemiology, diabetology, occupational epidemiology, occupational and maritime medicine, cardiology, and public health [15].

The aim of the group is to provide a foundation for safe and healthy preventive strategies within the UN Global Sustainable Goals. Seafarers around the world work under different climate conditions, 12 hours/day 7 days a week, away from home for several months at a time. Hence, seafarers are especially vulnerable compared to most shore workers and may need to be referred to specialists in suspected and confirmed cases of hypertension and/or diabetes. The group discussed the main problems with the diagnostics of diabetes using urine sticks and proposed ways to take adequate scientific-based diagnostics of seafarers in the fit-for-duty examinations with continuous registration of clinical data in the Excel Data Entry Form.

The proposed clinical data registration includes gender, nationality, work function/area on board in fishing and seafaring vessels, height and weight, body mass index, glycated haemoglobin (HbA1c), fasting glucose, waist circumference, blood pressure, smoking, intake of fruit and vegetables (grams) and physical activity. Waist circumference is suggested to be marginally better than body mass index as a surrogate marker for total body fat and can identify thinner people with increased visceral adipose tissue and increased cardio metabolic risk [16]. Waist action levels could be useful for health promotion to raise awareness of the need for weight management [17]. Automatic disease stage classification is added to the Excel spreadsheet for hypertension and diabetes according to the International Society of Hypertension Global Hypertension Practice Guidelines and the American Diabetes Association, respectively [18, 19].

ACCURATE DIAGNOSIS OF TYPE 2 DIABETES IN THE CLINIC

Urinary glucose has been widely used as a screening tool for diabetes since it is non-invasive, cheap and easy to perform. The problem with the low sensibility when using urine sticks for diagnosis of type 2 diabetes has existed for many years, but only recently been discussed in relation to maritime medical health examinations [12, 13].

Since 2011, HbA1c has been used to diagnose diabetes in most countries and replaced blood glucose performed in the fasting state or 2 hours after an oral

Table 1. Clinical variables to be recorded in the Excel file at the fit-for-duty medical exams

Variables	Value labels
1. INF	Informed Consent: Permission to use anonymised data for research: Yes = 1; No = 2
2. AGE	Years of age
3. GEN	Male = 1; Female = 2
4. NAT	Nationality: Own country = 1; Other = 2
5. WOR	Coastal fish bridge = 11; Coastal fish not bridge = 1; Deep sea fish bridge = 12; Deep sea fish not bridge = 2; Seafarer bridge = 3; Sea-deck = 4; Sea-engine = 5; Diver = 6; Off-shore = 7
6. MED	Taking medicine: No = 1; For diabetes = 2; For hypertension = 3; For both = 4
7. HEI	Cm (no decimals)
8. WEI	Kg (no decimals)
9. WAI	Cm (no decimals)
10. AC1	Glycated haemoglobin: %, 1 decimal
11. FG	Fasting glucose: mg/dL no decimals
12. SYS	Systolic blood pressure (no decimals)
13. DIA	Diastolic blood pressure (no decimals)
14. SMO	Smoker = 1; Non-smoker = 2; Ex-smoker = 3
15. FRU	Fruit and vegetables daily consume: high, small, none
16. PHY	Physical activity, involve all kinds of movement where you become short of breath: high, small, none

glucose tolerance test [20]. The use of HbA1c was made possible after establishment of a reference measurement procedure for international standardisation of routine A1c assays [21]. There were several reasons for this recommendation. HbA1c was already used in clinical practice for decision making on antidiabetic treatment. Compared to glucose measures, HbA1c is stronger associated with most long-term micro- and macrovascular diabetes complications [20]. Measurement variability is negligible (~1%) compared to blood glucose (12–15%) [22]. HbA1c does not require fasting and is obviously less time consuming than the cumbersome oral glucose tolerance test. To be considered, it was recently suggested that HbA1c may underestimate the prevalence of type 2 diabetes when compared with fasting glucose [23].

RESULTS

Table 1 shows the proposed clinical variables to be recorded with some examples of the classification and coding according to the international medical guidelines. Analysis of the epidemiological data will allow for the identification of trends in prevalence of diabetes and hypertension in different levels of severity in the population strata and countries to estimate the development and identify areas for intervention. Early and precise diagnostics contribute to improved clinical performance to start early prevention

and thus save quality-adjusted (QALY) living- and working years. The ILO is prompted to include this protocol with Tables 1–3 as supplement to Appendix F in the international guidelines for accurate diagnostics of diabetes, hypertension, medical advice and research. The National Maritime Authorities are prompted to revise the National Medical Certificates for Seafarers as for example the Danish and the Norwegian Forms according to the revised international guidelines [24, 25]. The seafarers' doctors are prompted to adapt the scientific protocol, to use the revised medical certificates and to transfer the data in Excel format to the competent national research institute for data analysis and reporting. The recorded data gives the maritime medical doctors a comprehensive overview of the risk stages for precise medical evaluation, medical dialogue, advice and for research (Excel Data Entry Form; Tables 1, 2).

MEDICAL FOLLOW-UP OF SEAFARERS WITH NEWLY DIAGNOSED TYPE 2 DIABETES

Patients with type 2 diabetes are evaluated and followed up in general practice in accordance with the national, in this case the Danish, common public health portal on the Internet and the Danish College of General Practitioners guidelines [26–29]. At the time of diagnosis and in the future, **at least annually**, an overall assessment is made of the patient's risk profile and relevant treatment needs. Reg-

Table 2. Examples of clinical variables automatic recoded for medical evaluation, personal health advice and research*

FRU	PHY	AGE	WORK	SMO	HTN	DM-HbA1c	DM-FG	BMI	BMI group
600	30	23	Coastal fish	Smoker	Stage 1	Normal	Normal	25.5	Over
600	30	63	Deep sea fish	Smoker	Stage 1	Normal	Normal	23.1	Norm
600	30	48	Sea bridge	Ex-smoker	Stage 1	Pre	Pre	30.5	Obes
600	30	61	Sea deck	Smoker	Normal	Normal	Pre	22.1	Norm
600	30	56	Sea engine	Non-smoker	Stage 1	Normal	Pre	22.2	Norm
600	30	32	Diver	Non-smoker	Normal	Pre	Pre	28.1	Over
600	30	52	Coastal fish	Non-smoker	Normal	Pre	Pre	26.3	Over
Hypertension stage codes (HTN)**				Systolic [mmHg]		Diastolic [mmHg]			
Normal				≤ 130		and		≤ 85	
High normal blood pressure (pre-hypertension)				131–139		and/or		85–89	
Grade 1 hypertension				140–159		and/or		90–99	
Grade 2 hypertension				≥ 160		and/or		≥ 100	
Diabetes stage codes (DM)***				HbA1c limits		Fasting glucose limits (en ayunas)			
Normal				≤ 39 mmol/L (5.6%)		≤ 100 mg/dL (≤ 5.5 mmol/L)			
Pre-diabetes				39–47 mmol/L (5.7–6.4%)		100–125 mg/dL (5.6–6.9 mmol/L)			
Diabetes				≥ 48 mmol/L (6.5%)		≥ 126 mg/dL (≥ 7.0 mmol/L)			

*Automatic recoded values based on the variable examples in Table 1 and the Excel Data Entry Form

**International Society of Hypertension Global Hypertension Practice Guidelines <https://www.ahajournals.org/doi/10.1161/HYPERTENSIONAHA.120.15026>

***American Diabetes Association <https://www.diabetes.org/diabetes/HbA1c/diagnosis>

ular check-ups according to the guidelines given in the national scientific societies clinical guidelines is a cardinal point in care (Table 3). The general practitioners and the diabetologists will take the **seafarers specific situation** in consideration at the checks:

- **annual checks** to track and follow the development of any diabetic complications and adjust the individual treatment plan;
- **intermediate checks** (typically every 3–6 months) to monitor whether the individual therapeutic goals are achieved in terms of diet, weight, exercise and other healthy lifestyles as well as blood sugar, blood pressure and lipids, and if necessary, adjust the treatment and/or goals;
- **self-monitoring of blood glucose for seafarers with type 2 diabetes is necessary.**

Instructions and relevant equipment in the medical chest on board are needed and proposed added to the actual revision of the International Medical Guide for Ships. A few crewmembers on board shall know how to measure blood glucose and to treat severe hypoglycaemia using intramuscular glucagon, which must be present on all ship chests. Request that equipment for self-control of type 2 diabetes should be in the Ships Medical Chest.

Compared to shore workers, seafarers are, due to their long-term stay away on the ships, socially vulnerable type 2 diabetes patients with a need for special attention, as described by Rogvi et al. [30]. If a person with diabetes develops any kind of diabetic complication, he or she should be referred to a specialized diabetes clinic if possible.

MEDICAL FOLLOW-UP OF SEAFARERS WITH NEWLY DIAGNOSED HYPERTENSION

Measuring blood pressure is one of the most common procedures performed at a medical office. For the accurate diagnosis and management of blood pressure, proper methods are recommended to be used [31]. Accurate measurement of blood pressure is essential to classify individuals, to ascertain blood pressure-related risk, and to guide management. A recognised automatic blood pressure measurement apparatus should be used [32]. Three measurements should be carried out by the examining physician while the person is in a seated position. In the 30 minutes before the blood pressure is taken, there should be no smoking, no caffeine nor exercise. In the 5 minutes before the blood pressure is taken the person should sit still.

Table 3. Danish College of General Practitioners (DASAM) type 2 diabetes follow-up checks*

	Diagnosis	Intermediate checks	Annual checks
Self-care in general	•		•
Objectively:			
Weight	•	•	•
Blood pressure	•	•	•
Foot examination	•		Possibly
Electrocardiogram (ECG)	•		Possibly
Biochemistry:			
HbA1c	•	•	•
Lipid status	•		•
S-creatinine/estimated glomerular filtration rate	•		•
Urinary albumin-creatinine ratio	•		•
Conversation about living conditions and work factors:			
Smoking status	•	•	•
Exercise habits	•	•	•
Diet/alcohol	•	•	•
Psychosocial support working condition on board	•		•
Insulin treatment: home/on board glucose measurement		•	•
Complication status	•	•	•
Medication review	•		•
Treatment goals	•	•	•
Other actions:			
Referral to patient-oriented teaching in the/hospital	•		•
Referral to podiatrist	•		•
Referral to dietitian	Possibly	•	Possibly
Eye examination	•		•
Dentist	Possibly		Possibly

*<https://vejledninger.dsam.dk/media/files/4/type2-ark1.pdf>

During the assessment of blood pressure it is necessary to make sure the cuff is of the right size and in the right place, the cuffed arm should be placed on a flat surface, like a table, and at heart level. The person should sit upright, with feet flat on floor and without having a conversation [33].

AVOID FOLLOWING

- Putting the cuff over clothing, rather than a bare arm, can add 10–40 mmHg to a measurement [34];
- Having a full bladder can raise the blood pressure with 10–15 mmHg;
- Talking or having a conversation can raise the blood pressure an additional 10–15 mmHg;

- Failing to support the arm at heart level can raise the blood pressure 10 mmHg;
- An unsupported back can increase a measurement by 5–10 mmHg. That same range applies to feet left dangling from an exam table or high chair;
- Crossing legs can raise the blood pressure 2–8 mmHg.

REFERRAL OF HYPERTENSIVE SEAFARERS TO HYPERTENSION CLINICS?

Compared to shore workers, seafarers are socially vulnerable with a need for special attention and may need to be referred to a hypertension clinic [35, 36]. A referral may also be relevant for providing instructions for self-hyperten-

sive control on board and at home. Automatic referral was made for newly diagnosed grade 1 hypertensive patients for further one-to-one dietitian counselling (on top of primary care physician's usual care). The findings did not support automatic referral of newly diagnosed grade 1 hypertensive patients [37].

MEASURE BLOOD PRESSURE ON A REGULAR BASIS ON BOARD AND AT HOME

Because high and elevated blood pressure often occurs without any symptoms, checking blood pressure is the only way to know for sure whether it is too high. It is important to measure blood pressure in seafarers who are being treated for high blood pressure. At least two automatic apparatus should be available on all ships in the event that one of the devices breaks [38, 39].

All seafarers can measure their blood pressure at home and at sea with a home blood pressure monitor. They can learn steps to lower the risk for health problems from high blood pressure such as heart disease and stroke. Instructions and the relevant equipment in the Ships Medical Chest on board are required [39]. In addition, courses are needed for the seafarers and the medical doctors as well as revisions of the International Medical Guide for Ships are on the way.

DISCUSSION

This is the first known attempt to introduce a permanent programme with Public Health science into maritime medicine combined with the seafarers' fit-for-duty health examinations. So far, the gold standard for fit-for-duty maritime health examinations does not include health promotion [40]. No attempts have been done to create a scientific protocol to combine fit-for-duty health examinations and scientific based health promotion projects, which is the aim here. With the increasing prevalence of non-communicable diseases and the low success rate for health promotion projects on board, there is a strong need to apply permanent Public health interventions in shipping [41, 42].

A focus on early and accurate screening for type 2 diabetes mellitus and hypertension seems to be cost-effective [43–47]. Sustainability is obtained by having seafarers coming biannually for medical examinations, anyway as a permanent intervention. Medical doctors' health dialogues with the seafarers during fit-for-duty examinations and the on-board health promotion initiatives to help for prevention and reversion of pre-diabetes and pre-hypertension (Fig. 1).

“GREEN SHIP” HEALTH PROMOTION FOR ALL CREW MEMBERS

Crew members generally span all age groups with increasing prevalence of overweight, dyslipidaemia, obesity

hypertension, and diabetes by increasing stages of development with age (Fig. 2). Early diagnostics and starting prevention is important in all age-groups as the risk factors for development of type 2 diabetes and hypertension develop with age across the lifespan for all crew members (and not only for those with the diseases). All crew members have the potential to develop these diseases and there is a need for continuous education on prevention to benefit from an overall prevention strategy culture for all age-groups. So, the preventive efforts should not be reserved for diagnosed seafarers, but should be extended to the entire crew. There is a need for ideas and studies on how to develop and implement a structure of sustainable “green” scientific-based health promotion systems for all crew members and all stakeholders [48].

To build a global preventive culture at the workplace, the ILO recommends education and training not only for the workers but for all stakeholders [49]. A question may arise, how the shipping leaders can help to promote mental health, physical activity and reduced boredom on board that potentially can affect the health of the seafarers. For example, to make it easier to add physical activity to the daily routines it is necessary to provide the needed time and access to on-site gyms and walking paths, thus creating a culture of health in the workplace, something similar to the inspiring German e-healthy ship project [50, 51].

A supportive healthy environment includes opportunities for all crew members with and without a diagnosis for allowance during their workdays for relevant work breaks, restroom visits, access to nutritious meals in good social company; access and time to physical activity in the mornings and middle of the days without fatigue. It is a problem that the basic education for seafarers and the managers does not include how to implement health promotion culture. Thus, there is a need for health promotion training besides the basic education for maritime doctors, seafarers, fishermen, maritime authorities, maritime universities, shipping companies and research institutes [52].

PREVENTIVE INTERVENTIONS

Continuous education, course activities, collection and analysis of scientific data are the core issues. Educational materials for seafarers, cooks, navigators, and other crew members on how to manage hypertension and type 2 diabetes on board will be developed. National research groups will produce and disseminate teaching materials, offer education, and conduct pilot testing of on-board health protocols in coordination with the international research group. Epidemiological and qualitative studies are needed to clarify how crew members keep their work and good health with well-treated hypertension and diabetes. The ILO is prompted to add the diagnostic protocol

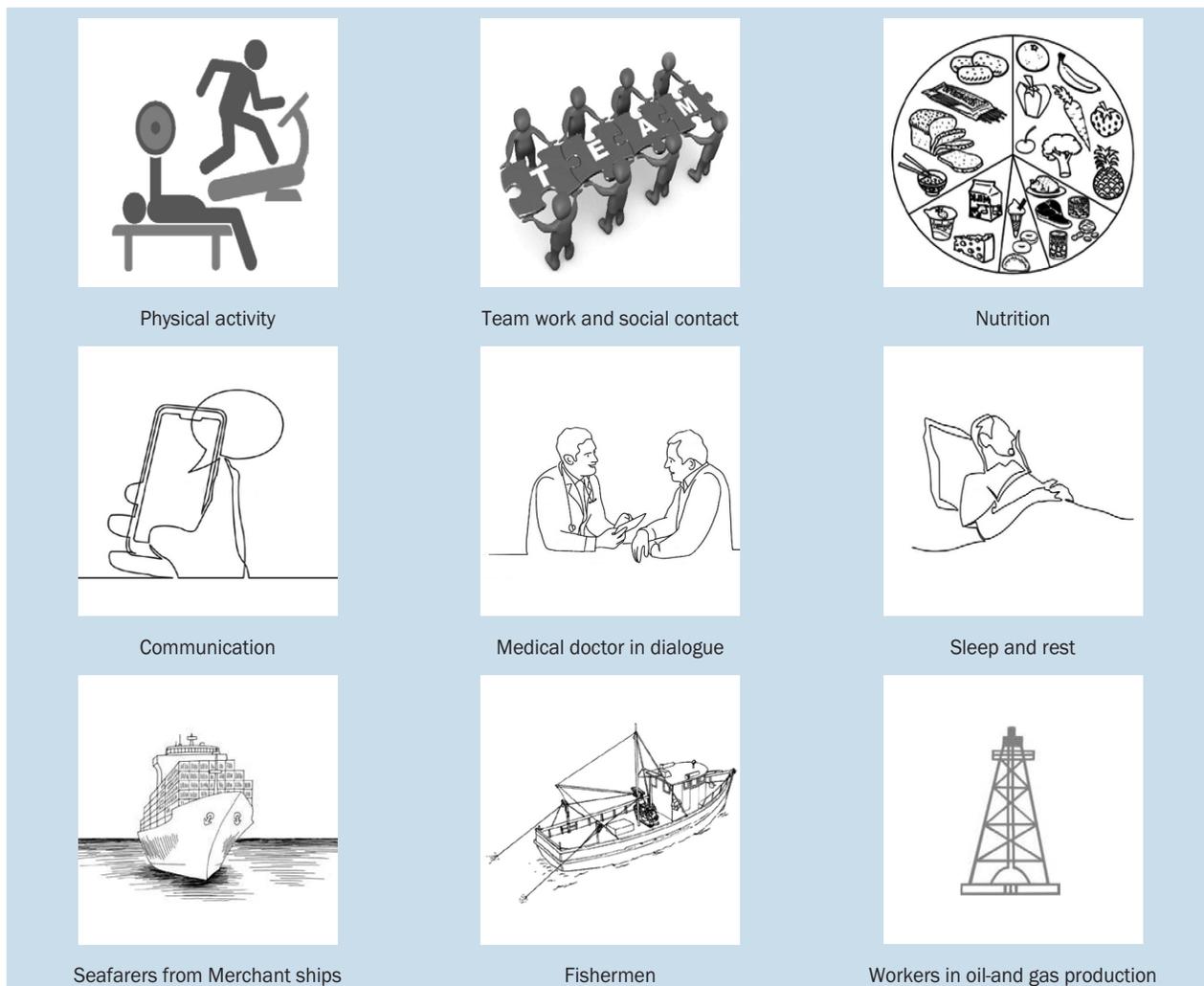


Figure 1. Maritime medical doctors are prompted to go into dialogue in the clinical fit-for-duty medical examinations with the seafarers on the personal health risk management related to the ongoing health promotion programs on the ships.

1	8%	14%	12%	11%	10%	11%	13%	11%	7%	3%
2	≤ 24	25–29	30–34	35–39	40–44	45–49	50–55	55–59	60–64	65+
3	Stage of susceptibility			Stage of subclinical disease			Stage of clinical disease		Stage of recovery or disability	
4	Normal			Pre-diabetes/pre-hypertension			Diabetes/hypertension		Treatment continues	

Figure 2. Age groups of merchant seafarers and the presumed age-related disease development. Rows 1–2 shows the distribution of the proportions (%) in each age group of merchant fleet seafarers based on data from Seamen Registry of Latvian Maritime Administration 2013 (reproduced from: Gaillitis R. Assessment of contribution of maritime education institutions in Latvian seafarers pool. *J Marit Transp Eng.* 2013; 2: 4–12). Rows 3–4 indicate the natural history of hypertension and diabetes mellitus development in an individual over the ages, in the absence of intervention, adapted from the United States Centres for Disease Control and Prevention principles of epidemiology (Principles of epidemiology; an introduction to applied epidemiology and biostatistics [Internet]. Available from: <https://stacks.cdc.gov/view/cdc/11200> [cited 2022 Feb 14]).

to their guidelines for fit-for-duty medical exams. Shipping companies, seafarers, and maritime medical doctors will develop, and pilot test the “Green Ship” health promotion for all on board. The German e-healthy ship is an example of an inspiring new-thinking in this area [50, 51, 53]. Health

promotion protocols for hypertension and diabetes with non-pharmacological and/or pharmacological management will be developed. Consensus meetings within the International Research Group for hypertension and Diabetes will decide which variables as a minimum are relevant for

international research collaboration. The maritime medical doctors are prompted to use health dialogues with the seafarers and to hand out further information with invitation to complete one of the Mahre-Net health questionnaires. Interview schemes in the maritime clinics need to be updated according to the protocol. Online training courses need to be developed and implemented for the stakeholders. The process will be a success when some ship owners, the seafarers and the medical doctors adopt the proposal even before the new protocol is implemented officially by the ILO and the National Maritime Authorities. In contrast to the few previous maritime health intervention studies conducted with poor results, this is a permanent intervention, to be successful over time [41, 42].

CONCLUSIONS

The ILO and the National Maritime Authorities are prompted to revise the International and the National Guidelines for Seafarers Medical Examinations, respectively with the scientific protocol. Seafarers' doctors are encouraged to align to the screening programme as part of the fit-for-duty health examinations and to use "health dialogues" with the seafarers. The researchers go in dialog with the stakeholders for planning of the "Green Ship" implementation. Random samples of the seafarers will complete questionnaires to evaluate the interventions. The "first movers" will be pioneers, starting to collect scientific data and paving the way for a permanent evidence-based health promotion in maritime medicine. The project connects well with the following Sustainable Development Goals: 3: Good health and well-being for all workers; 4: Quality education; 8: Decent work and economic growth; 10: Reduction of inequity; 17: Partnerships to achieve the goals with the primary tasks.

Conflict of interest: None declared

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