

# Hypertension among Danish seafarers

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## ABSTRACT

**Background:** Due to the high prevalence of arterial hypertension and its role in the development of atherosclerosis, myocardial infarction and stroke, hypertension is a major public health challenge worldwide. There is limited knowledge of the prevalence of hypertension among seafarers who, however, are known to have an excess morbidity and mortality from these disorders. This article addresses the prevalence of hypertension among Danish seafarers and discusses potential risk factors for hypertension in maritime settings.

**Materials and methods:** A representative sample of 629 Danish seafarers who had statutory medical examinations was studied from the beginning of October 2011 to the end of June 2012. The medical examination included measurements of blood pressure. The prevalence of hypertension in the study population was stratified by age, work place on board, smoking status, alcohol intake, and body mass index.

**Results:** The overall prevalence of hypertension in the study population was 44.7% (95% CI 40.8–48.6). In a comparison sample of adult Danes, the crude rate of hypertension was 12.6%. In addition, 41.8% (95% CI 38.0–45.7) of seafarers were pre-hypertensive. Hypertension was particularly increased among younger seafarers. The proportion of seafarers in antihypertensive treatment was low, in particular among the young seafarers.

**Conclusions:** Hypertension is a major health issue among Danish seafarers. In addition to ensuring anti-hypertensive treatment when needed, individual and collective prevention should address lifestyle issues as well as physical and psychosocial exposures at sea.

(Int Marit Health 2016; 67, 4: 196–204)

**Key words:** hypertension, pre-hypertension, seafarers, shift-work, noise on board, Denmark

## INTRODUCTION

Arterial hypertension is globally one of the leading causes of cardiovascular morbidity and mortality such as from myocardial infarction and stroke [1]. Empirical evidence has showed that the risk of cardiovascular diseases (CVD) doubles with an increase of the systolic blood pressure (SBP) by 20 mm Hg or the diastolic blood pressure (DBP) by 10 mm Hg [2]. Hypertension is estimated to cause 7.5 million annual deaths, which accounts for around 12.8% of deaths worldwide [3]. There is strong evidence that hypertension is preventable and that lowering blood pressure (BP) can significantly reduce the prevalence of CVD in hypertensive patients [4, 5].

A report from World Health Organisation estimated in 2008 that the overall prevalence of hypertension in adults aged 25 years and over was around 40%, with

considerable variation in between regions [3]. In Denmark, the age-adjusted prevalence of hypertension is 25.7% [6]. Hypertension is attributed to lifestyle-related as well as work-related risk factors, such as smoking, stress, high fat diet, and low physical activity. These factors determine the risks both in the general population and among seafarers [7].

Seafarers are required to consult a seaman's doctor for medical certification every second year. This medical examination aims to secure the safety of vessels and crews, but it also allows for detection of health problems such as increased BP at an early stage and may thereby contribute to reduce the risk of later overt diseases.

This article presents an empirical study of the prevalence among Danish seafarers of arterial hypertension and

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pre-hypertension and discusses the potential risk factors in the maritime environment.

## MATERIALS AND METHODS

### MATERIALS

The study group consisted of 655 Danish seafarers who were subjected to statutory medical examination [8] from the beginning of October 2011 to the end of June 2012. The enrolled seafarers were examined in four authorised seaman's doctors' clinics in Denmark, one located in Copenhagen, one in Odense and two clinics in Svendborg.

Out of 655 individuals, there was missing information for 26 people about BP ( $n = 23$ ) and age ( $n = 3$ ), resulting in 629 seafarers available for the statistical analysis of the prevalence of hypertension.

The study group was compared with BP measurements stratified by age and gender in a random Danish population sample from Funen [6].

### METHODS

The medical examinations were slightly expanded compared to the legal requirements and involved an interview and a physical examination. Of relevance for this study, the collected data included the seafarers' age, gender, height, weight, medication, workplace on board, and consumption of tobacco and alcohol. In addition, the seafarers had their BP measured with a standard sphygmomanometer. Based on height and weight the body mass index (BMI) was calculated. BMI was interpreted as  $< 18.5 \text{ kg/m}^2$  underweight,  $18.5\text{--}24.9 \text{ kg/m}^2$  normal weight,  $25\text{--}29.9 \text{ kg/m}^2$  overweight, and  $\geq 30 \text{ kg/m}^2$  obese.

The seafarers were stratified in 10-year groups with ages ranging from 16 to 77. Analyses were not conducted by gender but only by age, since the age-adjusted prevalence of hypertension is similar in males and females [6]. BP  $\geq 140/90 \text{ mm Hg}$  was recorded as hypertensive and BP between  $120/80 \text{ mm Hg}$  and  $140/90 \text{ mm Hg}$  as pre-hypertensive.

### STATISTICAL ANALYSIS

The data were converted from SPSS ver. 13.0 and analysed by STATA ver. 14.0. Categorical variables were presented as numbers and frequencies (%). A histogram showed normal distributions of the measured SBP and DBP (Figs. 1, 2). The point prevalence for both hypertension and pre-hypertension was reported for seven age groups and 95% confidence intervals (CI) calculated. Further analyses were conducted to study the relation of hypertension and pre-hypertension to BMI, smoking status, alcohol consumption, and work place on board.

### INFORMED CONSENT

This study was conducted in accordance with the Helsinki Declaration and approved by the local Ethics Committee (Ref. no. S-20110039). All participants signed informed consent before the medical examination.

### RESULTS

The distribution of DBP and SBP is illustrated in Figures 1 and 2. Out of 629 seafarers, 281 (44.7%) were hypertensive, while 263 (41.8%) were pre-hypertensive (Table 1). The age-specific prevalence of hypertension ranged from 28.6% in the youngest group ( $< 20$  years old) to 68.9% in the 60–69 years old group (Table 1, Fig. 3). There were major differences between the prevalence of hypertension in each age-group in the study population and the age-stratified prevalence in the reference Danish population (Fig. 3) [6]. The crude prevalence of hypertension in the latter was 12.6% (95% CI 11.9–13.4%).

According to self-reports, only 15.0% (95% CI 11.2–19.6%) of the hypertensive seafarers received treatment for hypertension. The remaining majority of hypertensive individuals (83.6%) were not in antihypertensive medication. In contrast 59.0% (95% CI 55.9–62.1%) of the hypertensive subjects in the control group received antihypertensive medication [6]. The self-reported treatment of hypertension in the different age groups varied greatly with young seafarers particularly undertreated (Fig. 4).

The studied sample of seafarers covered all workplaces on board (Fig. 5) and the prevalence of hypertension differed in between them (Table 2). Almost half of the seafarers who worked in the engine room had hypertension, followed by those who worked on deck.

There was slightly less hypertension in non-smokers than in former and current smokers. The highest prevalence was found in former smokers. Seafarers who consume more than 15 alcoholic beverages weekly had the highest prevalence of hypertension (Table 2).

The prevalence of hypertension increased with rising BMI (Fig. 6). Seafarers of normal weight had the smallest prevalence of hypertension, while the prevalence of hypertension in overweight and obese seafarers was 68.0% (Table 2). There was a high rate of overweight (38.3%) and obese (18.9%) seafarers in the studied sample. Only 44.4% were underweight or had normal weight (Table 3).

### DISCUSSION

This study has demonstrated a high and worrying prevalence of hypertension among Danish seafarers. The prevalence is more than three times the prevalence in the general Danish population. The study population was mainly male seafarers (89.5%), and because the prevalence of hyper-

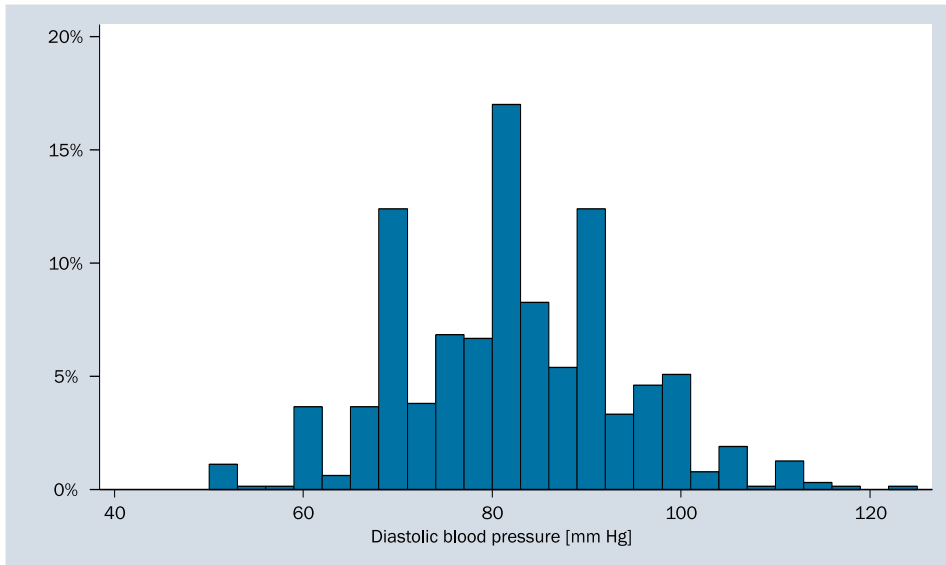


Figure 1. The distribution of diastolic blood pressure

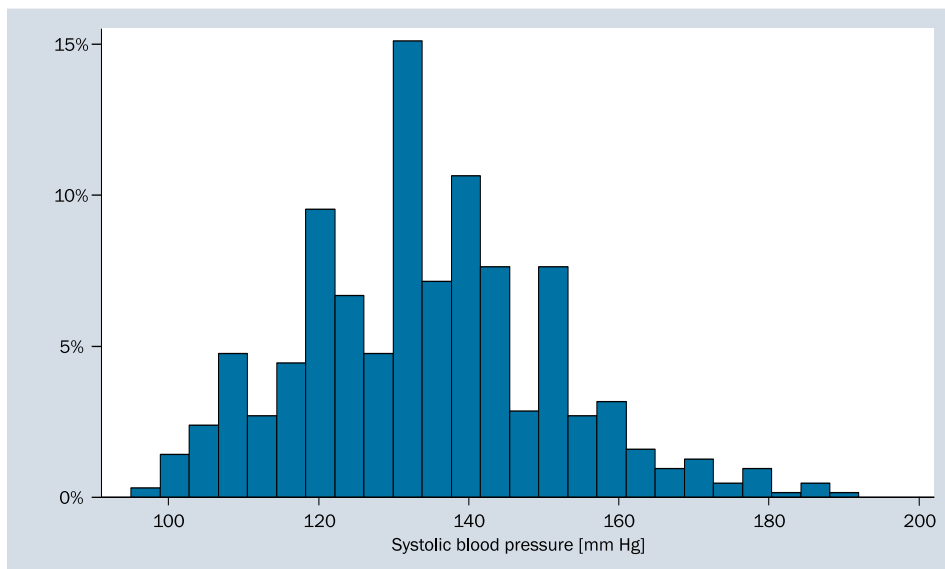
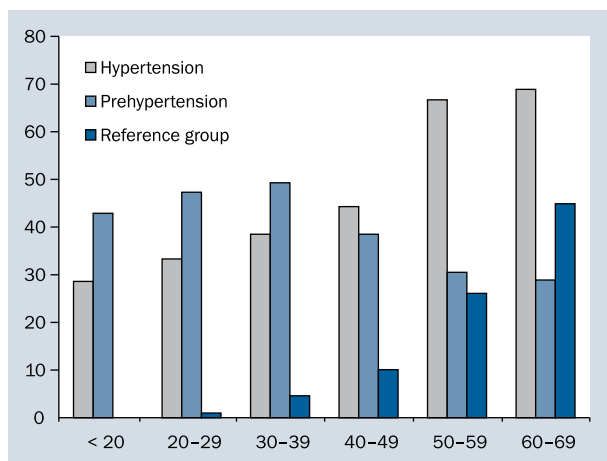


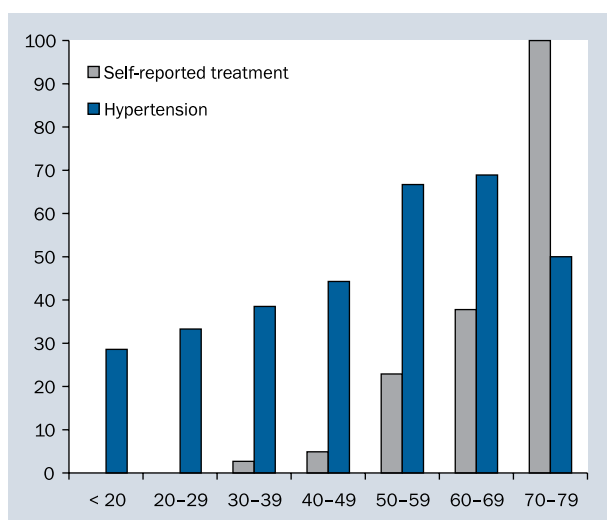
Figure 2. The distribution of systolic blood pressure

Table 1. Age-specific prevalence of hypertension, pre-hypertension, and treatment

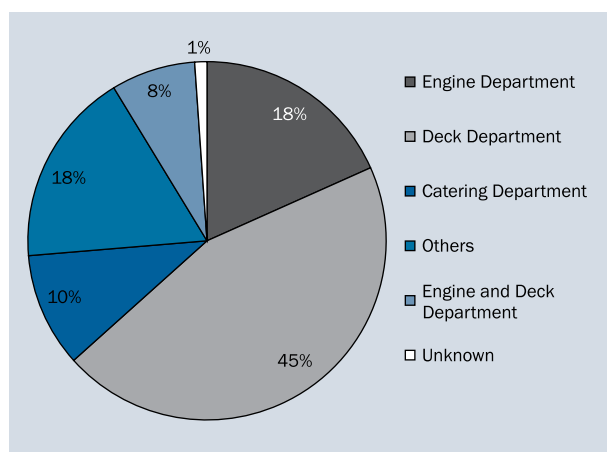
Age	Number of seafarers	Prevalence of hypertension [%] (95% CI)	Prevalence of pre-hypertension [%] (95% CI)	Prevalence of treatment [%] (95% CI)
< 20	21	28.6 (13.1–51.4)	42.9 (23.6–64.6)	0
20–29	186	33.3 (26.9–40.4)	47.3 (40.2–54.5)	0
30–39	148	38.5 (31.0–46.6)	49.3 (41.3–57.4)	2.7 (1–7)
40–49	122	44.3 (35.7–53.2)	38.5 (30.3–47.5)	4.9 (2.2–10.6)
50–59	105	66.7 (57.1–75.1)	30.5 (22.4–40.0)	22.9 (15.8–31.9)
60–69	45	68.9 (53.9–80.8)	28.9 (17.5–43.8)	37.8 (24.8–52.8)
70–79	2	50.0 (1.9–98.1)	50.0 (1.9–98.1)	100
All ages	629	44.7 (40.8–48.6)	41.8 (38.0–45.7)	8.4 (6.5–10.9)



**Figure 3.** The prevalence of hypertension and pre-hypertension in the study population of seafarers compared to the prevalence of hypertension in the reference population [6]



**Figure 4.** The proportion of hypertensive seafarers and the proportion of hypertensive seafarers in antihypertensive medication stratified by age



**Figure 5.** Distribution of seafarers with regard to work place on board (%)

tension is less influenced by gender [6] we have looked at male and female seafarers together but stratified by age. In all age-strata the prevalence of hypertension was much higher in seafarers than in control subjects. The prevalence of hypertension increased with age in both groups. It is, however, of particular concern that young seafarers were much more likely to be hypertensive than the general young population (Fig. 3). With 41.8% of the study population pre-hypertensive, only 85 (13.5%) of the studied 629 seafarers had a normal BP measured at the medical examination. One explanation of this finding is the high rate of overweight across all age groups (Table 3). The rate of overweight among seafarers has increased during the last decades, and today, Danish maritime students are more overweight than their peers even before they start to work at sea [9].

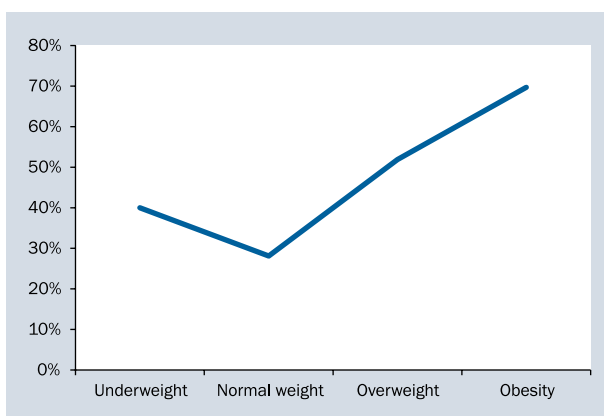
Arterial hypertension is a severe challenge globally, and the maritime setting appears to be a high-risk workplace for the development of hypertension. We believe that the studied sample is representative of Danish seafarers, and further that our findings can be generalised so that a high rate of hypertension is also likely to exist among seafarers in a global context who share similar maritime exposures and lifestyles as the Danish seafarers. This is supported by a French study that found significantly increasing prevalence of hypertensive seafarers from 14.8% the 1990s to 42.1% in the 2000s [10]. With a prevalence exceeding 40%, hypertension is also common in Spanish seafarers [11].

We have demonstrated that the majority of hypertensive seafarers in the studied sample did not receive antihypertensive medication. In fact, compared to hypertensive seafarers, seven times as many hypertensive subjects in the control group of Danes were in treatment [6]. A Danish population study based on BP data collected in 1998–1999 found a much higher prevalence of hypertension (38.5%) than today [12]. The previous prevalence of hypertension among Danes is comparable to the findings in today's seafarers. It is also noticeable that less than 1/4 were in antihypertensive treatment at the time [12], which also suggests challenges similar to those experienced by Danish seafarers. This high prevalence in the seafarers of hypertension and the low rate of antihypertensive treatment suggests the incapability of the health service to reach this population. However, it should be emphasized that pharmacological treatment may not always be indicated with minor increase of BP, and that in particular young people may as well benefit from lifestyle changes [13].

Hypertension is one of the main risk factors for CVD. There is an increased hospitalisation rate of CVD in seafarers [14]. CVD represent the most common cause of seafarers' death at sea. Up to 80% of disease-related deaths at sea have been attributed to diagnosed or presumed myocardial infarction [15]. Studies from United Kingdom

**Table 2.** The prevalence of hypertension in 629 seafarers

Variable	Number of seafarers	Number of hyper-tensive seafarers	Proportion [%]	95% confidence interval
<b>Work place on board</b>				
Engine Department	115	57	49.6	40.5–58.7
Deck Department	283	126	48.1	42.3–53.9
Catering Department	65	21	32.3	22.0–44.7
Others	111	41	36.9	28.4–46.3
Both engine and deck	48	22	45.8	32.6–60.0
Missing information	7	4	57.1	20.9–87.1
<b>Smoking status</b>				
Non-smoker	243	95	39.1	33.1–45.4
Current smoker	150	65	43.3	35.6–51.4
Former smoker	121	59	48.8	39.9–57.7
Unknown	115	49	42.9	12.9–79.1
<b>Alcohol consumption at home</b>				
Never	54	25	46.3	33.4–59.7
1–7 beverages	243	94	38.7	32.7–45.0
8–14 beverages	115	44	38.3	29.8–47.5
> 15 beverages	94	52	55.3	45.1–65.1
Unknown	123	51	41.7	17.7–70.4
<b>Body mass index</b>				
Underweight	5	2	40.0	8.2–83.2
Normal weight	256	72	28.1	22.9–34.0
Overweight	241	125	51.9	45.5–58.1
Obese	109	76	69.7	60.4–77.7
Missing information	18	6	33.3	15.4–57.9

**Figure 6.** The relation between hypertension (%) and body mass index

[16] and Denmark [17] have showed mortality rates of CVD of 43.4 and 27.9 per 100,000 seafarer-years, accounting for 71% and 55%, respectively, of natural deaths on board.

On top of that a significant number of cerebrovascular deaths can be related to hypertension. Failing to adhere to antihypertensive therapy increases the risk of fatal stroke in hypertensive individuals [5]. The situation has improved since then but remains concerning [18, 19].

In Denmark, the seamen's doctor is usually not the seafarer's general practitioner. The seamen's doctors' tasks are rather that of an executive health officers working on behalf of the Danish Maritime Authority. The purpose of the statutory medical "fit for duty" examination every second year is to ensure the individual seafarer's health and the safety of the ship. Therefore the assessment considers whether a certain disease or condition can cause an increased risk of acute complications that cannot be handled by a layman on board, and therefore may pose a significant risk for the seafarer. In addition, the examination should consider if sudden illness of a seafarer poses a risk to the safety or put other crew members in a needlessly difficult situation, and whether the condition causes difficulties

**Table 3.** The proportion of overweight and obesity stratified by age

Age	Number of overweight seafarers	Proportion [%]	95% confidence interval	Number of obese seafarers	Proportion [%]	95% confidence interval
< 20	0	–	–	1	4.7	0.6–28.2
20–29	51	27.4	21.5–34.3	14	7.5	4.5–12.3
30–39	62	41.9	34.1–50.0	25	16.9	11.7–23.8
40–49	57	46.7	38.0–55.6	26	21.3	14.9–29.5
50–59	46	43.8	34.6–53.5	31	29.5	21.5–39.0
60–69	24	53.3	38.7–67.4	11	24.4	14.0–39.2
70–79	1	50.0	1.9–98.0	1	50.0	1.9–98.0

for the seafarer to cope with an emergency on board. The examination provides an opportunity for detecting, treating and preventing any revealed deviations from health. But it seems that this option is only applied to a limited extent. For example, in Denmark, seafarers are not grounded, unless the SBP/DBP exceeds 180–200/110 mm Hg [20]. According to the American Heart Association, a BP on this level is very high and represents a medical emergency – a hypertensive crisis [21]. International Maritime Organisation have suggested lower limits (SBP/DBP 160/100 mm Hg) [22], which, however, is equivalent to hypertension stage 2 [21], which also represents a dangerous condition. The application of lower limits would most likely result in more seafarers being treated, so that they can safely continue their work at sea. It has indeed been suggested to include a cardiovascular risk assessment in the medical examination of seafarers for preventive purposes [13].

Seafarers may not visit their family doctors often due to long working periods at sea. For that reason it is particularly important that the seamen's doctors inform the seafarers about any concerning observation found in connection with the statutory medical examination and encourage the seafarer to consult his family doctor for control and indicated treatment. Pre-hypertensive and in particular hypertensive seafarers should be informed about the level of their BP and what that means in terms of health and management.

It is not in the explicit role of the seamen's doctors to follow up the health of the seafarers unless according to regulations adverse health prevents work at sea. Whether seafarers are informed about increased BP that is less than the limit of 180 mm Hg systolic/110 mm Hg diastolic is not known. According to Figures 1 and 2, a BP of that level is rare while increased lower stages of hypertension are very common. Even if informed about a high BP, the seafarer may not be able to follow a given advice regarding control/treatment, e.g. if the seafarer has to board immediately. After boarding, the seafarer will be distant from professional health care. The limited treatment options on board

focus on acute rather than chronic conditions, and control and treatment of hypertension is not within the scope of medical care on board [23]. Awareness and treatment of hypertension has been found to be associated with female sex, diabetes, CVD, age, contact to the general practitioner, diet and BMI [12]. Therefore, it is not surprising that the studied population of seafarers is disfavoured.

### RISK FACTORS ON BOARD

A multitude and combinations of risk factors on board can have an adverse health effect on seafarers' cardiovascular health [7, 10, 11, 24] and lead to elevated BP in seafarers [24–26]. Health consequences such as overweight and diabetes are other frequent consequences of life at sea that are related to hypertension [8].

**Food.** In spite of the fact that the seafarers' food is vital to their health [24] they have limited choices for healthy food on board. Overweight, which is an essential risk factor for the development of hypertension [27], becomes a frequent and severe problem among seafarers. An increase in BMI of about 10.3 kg/m<sup>2</sup> doubles the risk of hypertension [28]. A German study showed that 64% of seafarers were overweight, and that 16% of 351 male seafarers had a BMI in excess of 30 kg/m<sup>2</sup> [24]. A recent Danish study found even more alarming figures with 66% overweight seafarers, and that maritime students who enter the maritime business are already more overweight than other young people [9].

**Sedentary work.** Sedentary lifestyle is also an increasing challenge in modern seafaring. Low energy expenditure is related to prolonged sitting during work and in leisure time at sea [29]. There is a positive association between sedentary behaviours and hypertension, and individuals without daily physical exercise have a 20–50% higher risk of developing hypertension [30].

**Shift-work.** Irregular work poses a threat to health [31]. Many seafarers have to work in shifts to keep the vessel going. Shift work contributes to development of hypertension [32], not only by causing persistently elevated acute BP, but also by delaying BP recovery [32].



**Table 4.** Exposure limits in different work area on board and on land

Area	Control room	Office	Dining rooms	Sleeping area
IMO noise limit (dB) [36]	75	65	65	60
Noise limit land (dB) [37]	55	55	55	45

IMO – International Maritime Organisation

**Noise.** Exposure to road noise and nighttime aircraft noise is associated with high BP [33, 34], and it has been shown that the noise level in the workplace is proportional to the prevalence of hypertension [35]. Noise exposure of vessels' crews at sea is inevitable, and seafarers have to suffer from 24 h of daily background noise for several months on board. Measured noise levels are highest in the engine rooms, followed by the levels on deck [25]. This may partly explain the high prevalence of hypertension for seafarers working in these two areas. Noise can be stressful and disrupt sleep. A noise level of 40 dB to 50 dB is annoying during sleep, while 70 dB will disrupt the sleep for everyone. The main sources of mechanically created noise and vibration are the engines. The International Maritime Organisation regulates the maximum noise limits on board vessels [36], which, however, is higher than on land (Table 4) [37].

### LIMITATIONS OF THE STUDY

The major limitation of this study is the potential of flawed BP measurements, which may occur on several levels. Details regarding how the seafarers' doctors measured the BP's in this study are not known from the records. The BP measurements represented one-time checks in the clinics and may be influenced by personal factors such as poor sleep the previous night [38], emotions, and the effect of nicotine or drugs etc. and measurements may therefore overestimate the prevalence of hypertension and pre-hypertension [39]. Additional details regarding standards for measurement may apply and can vary in between the four clinics. One example is the potential of having different BP in the two arms. Generally, a difference within 10 mm Hg is regarded as acceptable [40]. However, we do not know the seaman's doctors' preferences, and it is unlikely that the recorded BP represents the mean value for both arms. Preparation of the subject before measurement of BP should involve positioning of the arm, and avoiding muscle tension, talking and background noise. Clothing that covers the location of cuff placement should be removed, and the individual should be comfortably seated, with legs uncrossed, and the back and arm supported so that the middle of the cuff on the upper arm is at the level of the mid-point of sternum. The patients should be instructed to relax and to not talk. Ideally 5 min should elapse before the first reading [39]. A "white coat effect" can occur at any age and is common in most patients. It can, however, hardly cause

major distortion of our results. In the control sample 14.4% were hypertensive according to the initial screening. This figure was only slightly reduced to 12.6% at subsequent BP measurements at home [6]. Lastly, the size of the applied cuff can influence BP measurements. An inappropriate cuff size leads to an inaccurate measurement of the BP [41, 42]. The cuff choice should reflect anthropometry such as the upper arm size. A too narrow cuff bladder width leads to an overestimation of BP, and a too wide bladder underestimate the true BP [43, 44]. The choice of an appropriate cuff size should be particularly considered for this group of seafarers, since 53.9% of them are overweight or obese. Such errors may result in higher readings of BP and consequently a higher prevalence of hypertension and pre-hypertension.

### CONCLUSIONS

The prevalence of hypertension among Danish seafarers is much higher than in the reference group of Danes, and particularly prominent in the younger age groups. The low rate of treatment indicates the need of further awareness and control of hypertension among seafarers. Seafaring is associated with specific risk factors that affects BP and can contribute to hypertension among seafarers. The role of lifestyle issues such as physical exercise, healthy food, and smoking should be communicated to the seafarers but cannot stand alone. In addition to individual counselling and management of seafarers with hypertension (and pre-hypertension), there is a need of collective mitigation at sea which should be a company responsibility. Such preventive activity should target the many risk factors at sea that are part of the maritime environment such as nutrition, sedentary lifestyle, noise and fatigue.

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