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Correlation between body mass index and blood pressure in seafarers

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ABSTRACT

Background: High blood pressure is a serious medical condition that significantly increases the risk of cardiovascular disease. Although overweight and high blood pressure are frequent consequences for the health of life at sea, there is a paucity of information on the contribution of body mass index (BMI) to high blood pressure (HBP) in seafarers.

Objective: The present study was aimed to examine the relationship between BMI and blood pressure and to analyze further BMI as a risk factor for high blood pressure through a modeling approach.

Materials and Methods: A retrospective analysis was performed on 603 seafarers' medical examination records. The seafarer's blood pressure and BMI were recorded and interpreted according to the WHO criteria. Pearson product-moment correlation was examined to determine the association between BMI and blood pressure. Multinomial logistic regression models were performed to estimate the strength of association between the BMI and the HBP.

Results: Out of a total of 603 seafarers under study, 44.4% and 55.6% were officers and non-officers, respectively. Mean SBP, DBP, and BMI were significantly higher among non-officers than officers. BMI was positively correlated ($p < .01$) with both SBP (r = 0.336) and DBP (r = 0.344). About 39% and 16.6% of the study subjects were prehypertension and hypertensive, respectively. The risk of prehypertension and hypertension was higher in individuals who were overweight and obese.

Conclusions: Mean blood pressure levels increase parallel to the rise of BMI. Thus, emphasis should be given on a weight management program in relation to the prevention and control of high blood pressure.

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Introduction

Globally, in 2019, approximately 1.13 billion people have high blood pressure. Of these, nearly 67% are living in low- and middle-income countries(1). In 2015, one in four men and one in five women had hypertension(1). Increased blood pressure is a serious medical condition that significantly increases the risk of cardiovascular diseases (CVD). Furthermore, it is the preventable risk factor for premature deaths worldwide(1). About 54% of strokes and 47% of coronary heart diseases are attributable to high blood pressure (2). Over 1.9 billion adults aged 18 and over were overweight in 2019, and among them, around 650 million adults were obese (3). Increased body mass index (BMI) is the main risk factor for CVD, diabetes, especially type 2, musculoskeletal disorders, and other chronic diseases such as certain cancers (3). Furthermore, in 2015, elevated BMI values were responsible for over four million deaths worldwide, and of these numbers, approximately 66% were attributed to CVD (4).

Seafaring is a dangerous occupation (5), characterized by physical and psychological stressors, sudden climate changes (6). Workers at sea have high rates of mortality, illness, and injury when compared to the general population (7). CVD is the leading cause of death onboard ships (8–10). Seafarers working and living conditions are characterized by long working hours, a short average of sleep times, night shift works, prolonged isolation from family, and work-related stress (5, 11–14). Furthermore, behavioral risk factors such as smoking, an unhealthy diet, physical inactivity, excessive alcohol consumption are highly prevalent among seafarers (15,16). This heavy consumption of alcohol and smoking could be due to hectic activity and lack of leisure-time onboard.

Several studies have found that nutritional factors, shift work, sleep patterns, work-related stress, and fatigue may play a critical role in increasing coronary heart diseases (CHD) and other metabolic syndromes such as central obesity, glucose intolerance, and hypertension (16–19). Also, another work reported that work-related stress increased by over 50% of CHD risk (20). High blood pressure (hypertension) remains the most important and well-documented modifiable risk factor for CVD, such as stroke and coronary heart disease (21). In contrast, risk factors such as smoking, lack of exercise, alcohol abuse, increased BMI value, and an unhealthy diet can play a vital role in the cause of arterial hypertension (22,23). Health consequences such as high BMI, diabetes, and hypertension (HBP) are frequent consequences of life at sea (24–26).

In general, there are several studies on the relationship between body mass index (BMI) and blood pressure (BP) in general populations (27–31). The positive association between BMI and BP is well documented (27,29, 32–35). However, this relationship is not studied in seafarers. Some studies have reported the prevalence of high blood pressure and overweight/

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obesity among seafarers. It has been reported that the occurrence of hypertension was 49% among Lithuanian mariners (24), 44.7% among Danish seafarers (25), 49.7% among seafarers in German-flagged ships (16), 19.2% among Iranian seafarers (36). Furthermore, the prevalence of overweight and obese was 50% and 20% among Danish seafarers (37), 42.5% and 8.6% among Iranian seafarers (36), and 40.8% and 11.2% among seafarers in Italian Flagged vessels (38), respectively.

The aims of this study are 1) to examine the relationship between Body mass index (BMI) and blood pressure in seafarers; 2) to analyze further BMI as a risk factor for high blood pressure (HBP) in seafarers through a modeling approach.

Materials and methods

A retrospective study was carried out on 603 seafarer's medical examination records. In Italian flagships, all seafarers are required to undergo medical examination two times per year (every 6 months) due to the rigorous demand for work onboard ships. The medical examination was conducted by the International Radio Medical Center (C.I.R.M.) physicians and other trained health professionals. C.I.R.M. is an Italian Telemedical Maritime Assistance Service (TMAS) Center and is the organization with the largest experience worldwide in terms of the number of patients assisted and various health surveillance activities performed onboard ships. During the medical examination, seafarers undergo an interview with physicians or trained health professionals, physical examination and measurements, and laboratory tests. All medical examination results are recorded in the C.I.R.M. database. For this study, we analyzed 603 seafarer's medical examination records, carried out between 2018 and 2019 on board of Italian Flagships. Data on weight, height, age, sex, rank, blood pressure value, smoking, and physical activity were extracted from the database by the authors of this study.

Blood pressure (BP), height, and body weight measurements were taken by trained health professionals and physicians. In addition to physical measurements, seafarers who are subjected to medical examinations were interviewed information about demographic data such as age, rank, and other necessary information, including smoking habits and physical activity. Physical activity is defined as seafarers involved in vigorous or moderate exercise or engaged in activities such as carrying or lifting heavy loads for at least 10 minutes continuously. The seafarer's blood pressure, as well as other measurements, were recorded and interpreted according to the WHO criteria (39). Regarding blood pressure, subjects were categorized into three groups: normal blood pressure, prehypertensive, and hypertensive. Normal blood pressure was taken as systolic blood pressure (SBP) <120 mmHg and diastolic blood pressure (DBP) <80 mmHg, whereas SBP reading of 120–139 mmHg and/or DBP value of 80–89 mmHg were classified as prehypertensive. Blood pressure values of SBP ≥140 mmHg and/or DBP ≥90 mmHg and/or self-reported use of antihypertensive medication were classified as hypertensive (39). BMI was determined as weight in kilograms (kg) divided by height in meters (m) squared [Weight (kg)/Height $(m)^2$]. BMI was also classified according to WHO guideline, underweight (<18.5 kg/m^2), normal body weight (18.5–24.99 kg/m^2), overweight (25–29.99 kg/m^2) and obesity (≥30 kg/m^2) (40).

Statistical analysis

Statistical analysis was carried out by using STATA software version 15. Descriptive statistics such as mean and standard deviation were analyzed to evaluate the mean value of SBP, DBP, BMI, Height, age, and the bodyweight of the participants. Chi-square and independent sample t-tests were performed to determine the differences in the distribution of categorical variables and continuous variables between rank groups. Pearson product-moment correlation was examined to determine the strength of the association between BMI and BP (SBP and DBP). ANOVA (One – way analysis of variance) was employed to determine differences in the mean value of blood pressure (both SBP and DBP) between age groups and BMI categories.

Multinomial logistic regression models were performed to determine the association between the predictor variables and the dependent variable. The dependent variable (blood pressure) was classified into three groups: normal (reference category), prehypertension, and hypertension. Hence, the multinomial regression model compared the probability in the categories of normal vs. prehypertension and normal vs. hypertension and adjusted for age. The independent variables were BMI, rank group, cigarette smoking, and physical activity. A $p < .05$ was considered statistically significant.

Results

Characteristics of the study participants

A total of 603 seafarers underwent a medical examination onboard Italian Flagships. Of these, 44.4% (268) were officers, and the remaining 335 (55.6%) were non- officers. About 28.4% of officers and 41.2% of non-officers were smoked cigarettes, and cigarette smoking levels differed significantly between the rank group ($p = .001$). Almost 86% (517) of the participants were engaged in any physical exercises. The mean value of height was significantly higher among officers when compared to non-officers. In contrast, average SBP, DBP, and BMI were significantly higher in non-officers than officers. Almost all (98.2%) of the participants were male, and the remaining 1.8% were female (Table 1).

Prevalence of high blood pressure

The prevalence of prehypertension (SBP: 120–139 mmHg and/or DBP: 80–89 mmHg) and hypertension (SBP > = 140 mmHg and/or DBP > = 90 mmHg) was 39% (95% CI: 35–43%) and 16.6% (95% CI: 13.7–19.8%) in individuals, respectively. Overall, high blood pressure was seen in 56% of the participants. Regarding rank distribution, prehypertension found in 34% of officers and 43% of non-officers. Also, hypertension observed in 9% of officers and 22.4% of non-officers. The differences in blood pressure levels between officers and non-

Table 1. Characteristics of the study participants (n = 603).

Characteristics	Overall	Officer	Non-officer	*P-value
Age group (years)				
≤ 30	161	85	76	0.082
31 - 40	227	96	131	
41-50	124	48	76	
≥ 51	91	39	52	
Mean age ± S.D (years)	37.37 ± 10.53	36 ± 10.2	38.22 ± 10.72	0.026
Mean Height ± S.D (cm)	174.5 ± 8.88	175.7 ± 7.88	173.54 ± 9.51	0.003
Mean Weight ± S.D (kg)	77.78 ± 11.09	77.5 ± 11.56	78.04 ± 10.69	0.514
Mean BMI (kg/m^2) ± S.D	25.55 ± 3.24	25.05 ± 3.14	25.94 ± 3.27	0.001
Mean SBP ± S.D (mmHg)	125.91 ± 10.12	123.70 ± 10.47	127.86 ± 9.48	<0.001
Mean DBP ± S.D (mmHg)	83.45 ± 7.48	82.41 ± 6.09	84.36 ± 8.32	0.001
Currently, smoking any tobacco products				
Yes	214	76	138	0.001
No	389	192	197	
Engaged in any exercise				
Yes	517	224	293	0.176
No	86	44	42	

S.D = standard deviation, kg = kilogram, cm = centimeters, mmHg = millimeter of mercury.
SBP = systolic blood pressure, DBP = diastolic blood pressure, m = meters, *P < 0.05 comparing non-officers vs. officers.

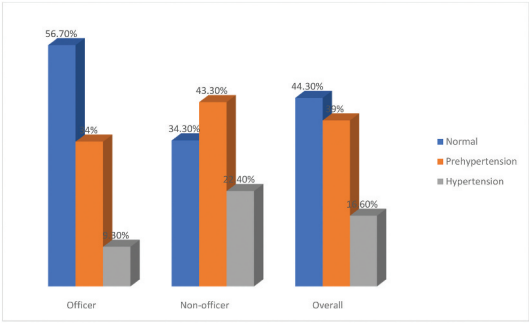

Figure 1. Percentage distribution of blood pressure levels among seafarers by rank group.

officers were statistically significant[$X^2(2) = 35.48$, $P < .001$] (Figure 1).

Prevalence of overweight and obesity by seafarer's rank

A significant difference between BMI categories and rank group [X^2 (2) = 7.54, $p = .023$] was noticeable. Almost 40% and 9% of the total subjects were overweight and obese, respectively. The high number of non-officers was overweight (42%) and obese (10.5%) compared to officers (Figure 2).

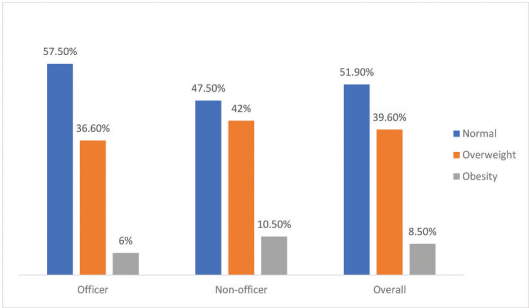

Figure 2. Percentage distribution of body mass index (BMI) levels by seafarer's rank group.

Distribution of blood pressure by different BMI categories

As shown in Figure 3, 46% and 24.7% of overweight seafarers had prehypertension and hypertension, respectively. The maximum percentage of obese study subjects had prehypertension (47%) and hypertension (39%). The differences in blood pressure levels across various BMI categories were statistically significant ($X^2(2) = 92.71$, $p < .001$).

Mean systolic and diastolic blood pressure in different age and BMI category

Both the average systolic and diastolic blood pressure were lower for the age group less than or equal to 30 y. The highest mean systolic BP was found among the oldest age group (>=51 y), and the differences were also statistically significant. Average diastolic BP increased from the age group <=30 y to 31–40 y and from 41–50 y to >=51 y. The highest mean DBP was found in the age group 31–40 y and significantly differed across the age groups. The mean SBP and DBP increased from normal body weight to obese category. The minimum average value of systolic and diastolic blood pressure was found among normal bodyweight category, and maximum mean systolic and diastolic blood pressure were found in obese category. The differences both in average systolic and diastolic blood pressure between BMI categories were statistically significant (Table 2).

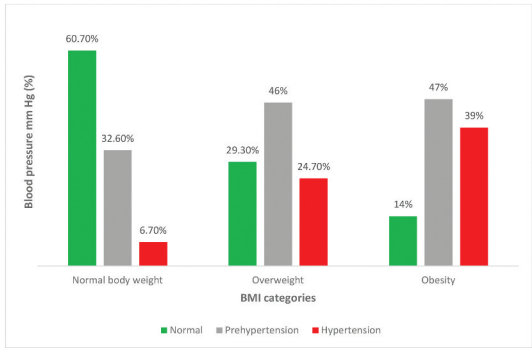

Figure 3. Percentage distribution of blood pressure among seafarers by BMI categories.

Table 2. Blood pressure among seafarers in different age groups and BMI categories.

		Systolic blood pressure (mmHg)				Diastolic blood pressure (mmHg)			
	Number of participants **n(%)**	Mean score	±SD	±SE	F-test	Mean score	±SD	±SE	F-test
Age group					4.332**				4.350***
≤30 y	161 (26.7)	124.33	7.97	0.63		82.09	4.95	0.39	
31–40 y	227 (37.6)	126.23	9.61	0.64		84.49	9.02	0.59	
41–50 y	124 (20.6)	125.16	12.49	1.12		82.60	7.66	0.69	
≥ 51 y	91 (15.1)	128.90	10.62	1.11		84.42	6.24	0.65	
BMI category					58.691***				65.773***
Normal	313 (51.9)	122.25	7.25	0.41		80.53	4.47	0.25	
Overweight	239 (39.6)	128.84	9.81	0.63		85.98	8.14	0.53	
Obesity	51 (8.5)	134.61	15.68	2.19		89.51	10.64	1.49	

Significant at the **p < 0.01, ***p < 0.001, F-test: variance-ratio test.

Table 3. Correlation matrix between blood pressure, BMI and age in seafarers.

Variables	BMI	Systolic BP	Diastolic BP	Age
BMI	1.00	0.336**	0.344**	0.313**
Systolic blood pressure	0.336**	1.00	0.640**	0.174**
Diastolic blood pressure	0.344**	0.640**	1.00	0.122**
Age	0.313**	0.174**	0.122**	1.00

Statistically significant at the **p < 0.01(2-tailed).

Body mass index and blood pressure

A positive and statistically significant correlation of BMI with both systolic BP and diastolic BP was observed. This study showed that blood pressure increases while increasing BMI. The correlation of BMI with diastolic BP was stronger when compared to systolic BP. Age was also positively and significantly correlated with systolic and diastolic blood pressure. However, the correlation of age with BMI was stronger than with systolic and diastolic BP (Table 3) .

Body mass index as a risk factor for high blood pressure

The multinomial regression analysis revealed that BMI and rank of seafarers were the significant predictors of high blood pressure. The odds of prehypertension and hypertension were more than eight and sixteen folds among obese individuals. Non-officers had a significantly higher risk of both prehypertension and hypertension compared to the officers. Being physically active and nonsmoker had a lower risk for both prehypertension and hypertension, but not statistically significant. As assessed by blood pressure, those who were overweight were 3.62 and 6.70 times more likely to have prehypertension and hypertension, respectively, than those who were in the normal BMI groups (Table 4).

Discussion

This study has examined the relationship between BMI and BP, both SBP and DBP among seafarers. As a result, BMI was positively and significantly correlated with both systolic and diastolic blood pressure. However, the relationship between BMI and diastolic blood pressure (r = 0.344) was observed to be stronger than systolic blood pressure (r = 0.336). Besides, a significant positive correlation was observed between age and both SBP and DBP in seafarers, although the correlation coefficients were weak [r = 0.174 (SBP) and r = 0.122 (DBP)]. On the other hand, the correlation of age with BMI was found to be stronger than with both systolic and diastolic blood pressure. There is no earlier comparable research regarding the relationship between BMI and BP in seafarers.

This study showed that the average BMI, SBP, and DBP were significantly higher among non-officers compared to the officers by rank group ($p < .001$). Mean SBP and DBP increased significantly with age consistently from the younger age groups (≤30 y) to the older age groups (greater than or equal to 51 y) of individuals. This shows that the dependence of blood pressure on the age of seafarers. Similarly, the average systolic and

Table 4. Determinants of high blood pressure among seafarers estimated with a multinomial logistic regression model (n = 603).

	Blood Pressure (mmHg)			
	Prehypertension		Hypertension	
	OR (95% CI)	P- value	OR (95% CI)	P-value
BMI category				
Normal	1		1	
Overweight	3.62 (2.35–5.58)***	<0.001	6.70 (3.74–12.01)***	<0.001
Obesity	8.24 (3.59–18.88)***	<0.001	16.75 (6.57–42.73)***	<0.001
Rank group				
Officer	1		1	
Non-officer	3.39 (2.21–5.20)***	<0.001	4.83 (2.75–8.46)***	<0.001
Cigarette smoking				
No	0.98 (0.63–1.52)	0.925	0.80 (0.47–1.37)	0.153
Yes	1		1	
Physical activity				
No	1		1	
Yes	0.87 (0.48–1.59)	0.657	0.78 (0.35–1.74)	0.540

Significant at the ***P<0.001, the odds ratio was adjusted for age.

diastolic BP increased significantly with increasing BMI steadily from healthy body weight to obese category. Thus, mean systolic and diastolic blood pressure increased with increasing BMI levels.

Our study documented that nearly 40% and 9% of the study participants were overweight and obese, respectively. Similar findings were documented in other studies carried out in seafarers (36,38). Our finding was not consistent with the study conducted among Danish sailors, which reported 70.8% overweight (41). Another study reported 76.6% and 30.9% of overweight and obesity, respectively, among Danish seafarers (42). The rank-specific prevalence of overweight and obesity significantly increased among non-officers compared to officers. This might be due to work-related stress and poor psychological emotions (e.g., depression, anxiety, and negative emotions) because non-officers (deck crew and engine crew) work is characterized by night shift work, long working hours, short average sleep time and often sleep interruptions, and physical stress. Several studies have reported that work-related stress and negative emotions (e.g., negative mood) are risk factors for high BMI (overweight and obesity) by promoting poor health behaviors, such as unhealthy diet, insufficient physical activity, excessive alcohol use, and smoking (43–46). Thus, work-related stress contributes to bodyweight gain (43) and abdominal obesity (47,48). We found that a high number of overweight individuals had prehypertension (46%). Furthermore, the maximum percentage of obese subjects in the study had prehypertension (47%) and hypertension (39%). In other words, the prevalence of both prehypertension and hypertension significantly higher in individuals who were overweight and obese than those of healthy bodyweight categories.

This study found a high prevalence of both prehypertension and hypertension among non-officers when compared to officers. Also, the difference between high blood pressure distribution between rank groups was statistically significant ($p < .001$). In other words, the prevalence of high blood pressure was significantly higher in non-officers (65.7%), with 43% being prehypertensive and 22.4% being hypertensive. This could be due to work stress and hectic activity onboard ships. Officers have high-level responsibilities such as navigation, planning, and control of the ship (12,49). In contrast, non-officers' jobs are characterized by mooring and unmooring the vessel, loading, and unloading cargo (49,50); hence, non-officers works are physically more demanding and stressful than officer's jobs. Different studies have revealed that job-related stress contributes to the development of coronary heart diseases (CHD) (19) and metabolic syndromes (51), such as high blood pressure.

In this study, multinomial logistic regression analysis identified overweight, obesity, and rank of the seafarers as significant determinants of both prehypertension and hypertension. The odds of high blood pressure, both prehypertension, and hypertension more than three and four folds among non-officers compared to officers. The risk of elevated blood pressure is significantly higher among individuals with overweight and obesity categories. In other words, the odds of prehypertension and hypertension were 3.62 and 6.70 times higher among individuals who were overweight compared to the normal bodyweight categories. Similarly, the odds of prehypertension among those in obesity categories were 8.24 times higher than individuals in healthy bodyweight categories. The risk of hypertension was significantly highest among individuals in the obesity groups [OR = 16.70, 95% CI: 6.57–42.73; $p < .001$] compared to those who were in the healthy bodyweight categories. Being physically active and not smoking had a lower risk of hypertension, although the difference was not statistically significant. Our work was limited by the use of retrospective data, and we did not have some important variables such as dietary variables, which could be potential confounders or mediators for the observed associations. Additionally, we did not consider information on antihypertensive medication due to a lack of information in the datasets. However, our work is the first to examine the relationship between BMI and blood pressure in seafarers.

Conclusion

The present study showed a positive and significant relationship between BMI and blood pressure. There were significant positive correlations between BMI, age, SBP, and DBP, although the magnitude of the correlation differed. Our work documented a significantly high prevalence of prehypertension among overweight and obese seafarers. Furthermore, overweight and obesity are strong predictors for high blood pressure, both prehypertension and hypertension in seafarers. The risk of high blood pressure was highest among individuals who were obese. In other words, blood pressure increases while increasing BMI levels. Hence, attention should be given on weight management program in relation to the prevention and control of high blood pressure. Seafarer health interventions targeting to reduce BMI would have significant effects in reducing the burden of high blood pressure on board ships.

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Ethical considerations

The study has been reviewed and approved by the C.I.R.M. ethics, scientific, and medical committee. Seafarers gave written informed consent to C.I.R.M. during a medical examination for the examinations as well as for the use of their medical data in anonymous form for research purposes related to the investigation of their health condition and for epidemiological studies.

Disclosure of interest

The authors report no conflict of interest.

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Authors' contributions

GGS designed study, performed analysis, methodology, interpreted the data and results, and drafted manuscript. MD extracted data and participated in manuscript preparation. FA guided, edited, reviewed, and approved the study. All authors approved the final manuscript.

References

1. World Health Organization. Hypertension. 2019. [Accessed 2020 Aug 16]. https://www.who.int/health-topics/hypertension/#tab=tab_1
2. Lawes CMM, Vander HS, Rodgers A, Society I. 2001. Global burden of blood-pressure-related disease, 2001. Lancet. 371 (9623):1513–18. doi:10.1016/S0140-6736(08)60655-8
3. World Health Organization. Obesity and overweight. 2020. [Accessed Aug 16 2020]. https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight
4. Afshin A, Forouzanfar MH, Reitsma MB, Sur P, Estep K, Lee A, Marczak L, Mokdad AH, Moradi-Lakeh M, Naghavi M, et al. Health effects of overweight and obesity in 195 countries over 25 years. N Engl J Med. 2017;377(1):13–27. doi:10.1056/NEJMoa1614362.
5. Oldenburg M, Baur X, Schlaich C. 2010. Occupational risks and challenges of seafaring. J Occup Health. 52(5):249–56. doi:10.1539/joh.K10004
6. Sagaro GG, Amenta F. 2020. Past, present, and future perspectives of telemedical assistance at sea: a systematic review. Int Marit Health. 71(2):97–104. doi:10.5603/IMH.2020.0018
7. Mulić R, Vidan P. Comparative analysis of medical assistance to seafarers in the world and the republic of Croatia. *15th Int Conf Transp Sci*. 2012:1–8. Zrinsko Frankopanska 38, 21000 Split, Croatia. https://bib.irb.hr/datoteka/587264.Mulic_Vidan_Bosnjak.pdf
8. Oldenburg M, Herzog J, Harth V. Seafarer deaths at sea: A German mortality study. Occup Med (Chic Ill). 2016;66:135–37. doi:10.1093/occmed/kqv153.
9. Alves PM, Leigh R, Bartos G, Mody R, Gholson L, Nerwich N. Cardiovascular events on board commercial maritime vessels: a two-year review. Int Marit Health. 2010;62(3):137–42. http://www.ncbi.nlm.nih.gov/pubmed/21154300.
10. Grappasonni I, Petrelli F, Amenta F. Deaths on board ships assisted by the centro internazionale radio medico in the last 25 years. Travel Med Infect Dis. 2012;10:186–91.:doi:10.1016/j.tmaid.2012.06.006.
11. Berg HP, Factors H. 2013. Safety culture in maritime safety (revised). Mar Navig Saf Sea Transp STCW, Marit Educ Train (MET), Hum Resour Crew Manning, Marit Policy, Logist Econ Matters. 7(3):107–15. doi:10.12716/1001.07.03.04
12. Oldenburg M, Jensen HJ. Stress and strain among seafarers related to the occupational groups. Int J Environ Res Public Health. 2019;16:7. doi:10.3390/ijerph16071153.
13. Harrington JM.Health effects of shift work and extended hours of work. Occup Environ Med. 2001;58(1):68–72.
14. Spurgeon A, Harrington JM, Cooper CL. 1997. Health and safety problems associated with long working hours: A review of the current position. Occup Environ Med. 54(6):367–75. doi:10.1136/oem.54.6.367
15. Hjarnoe L, international AL-H promotion, 2014. A risky occupation?(Un) healthy lifestyle behaviors among Danish seafarers. *academic.oup.com*. [Accessed 2020 June 11]. https://academic.oup.com/heapro/article-abstract/29/4/720/565098
16. Oldenburg M, Jensen HJ, Latza U, Baur X. 2008. Coronary risks among seafarers aboard German-flagged ships. Int Arch Occup Environ Health. 81(6):735–41. doi:10.1007/s00420-007-0261-5
17. Almadi T, Cathers I, Chow CM. 2013. Associations among work-related stress, cortisol, inflammation, and metabolic syndrome. Psychophysiology. 50(9):821–30. doi:10.1111/psyp.12069
18. Kaltsas G, Vgontzas A, Chrousos G. 2010. Fatigue, Endocrinopathies, and Metabolic Disorders. Pm R. 2(5):393–98. doi:10.1016/j.pmrj.2010.04.011
19. Cooper CARYL, Marshall JUDI.Occupational sources of stress: a review of the literature relating to coronary heart disease and mental ill health. J Occup Psychol. 1976;49(1):11–28.
20. Kivimäki M, Virtanen M, Elovainio M, Kouvonen A, Väänänen A, Vahtera J. 2006. Work stress in the etiology of coronary heart disease - A meta-analysis. Scand J Work Environ Heal. 32 (6):431–42. doi:10.5271/sjweh.1049
21. Polonikov AV, Vialykh EK, Churnosov MI, Illig T, Freidin MB, Vasil'eva OV, Bushueva OY, Ryzhaeva VN, Bulgakova IV, Solodilova MA. The C718T polymorphism in the 3′-untranslated region of glutathione peroxidase-4 gene is a predictor of cerebral stroke in patients with essential hypertension. Hypertens Res. 2012;35(5):507–12. doi:10.1038/hr.2011.213.
22. Kannel WB. 2004. Hypertensive risk assessment: Cardiovascular risk factors and hypertension. J Clin Hypertens (Greenwich). 6(7): 393-9. doi: 10.1111/j.1524-6175.2004.03605.x.
23. Labarthe D, Ayala C. 2002. Nondrug interventions in hypertension prevention and control. Cardiol Clin. 20(2):249–63. doi:10.1016/S0733-8651(01)00003-0
24. Kirkutis A, Norkiene S, Griciene P, Gricius J, Yang S, Gintautas J. Prevalence of hypertension in Lithuanian mariners. Proc West Pharmacol Soc. 2004;47:71–75.
25. Tu M, Jepsen JR. 2016. Hypertension among Danish seafarers. Int Marit Health. 67(4):196–204. doi:10.5603/IMH.2016.0037
26. Møller Pedersen SF, Jepsen JR. 2013. The metabolic syndrome among Danish seafarers. Int Marit Health. 64(4):183–90. doi:10.5603/IMH.2013.0002
27. Dua S, Bhuker M, Sharma P, Dhall M, Kapoor S. 2014. Body mass index relates to blood pressure among adults. N Am J Med Sci. 6 (2):89–95. doi:10.4103/1947-2714.127751
28. Vuvor F. 2017. Correlation of Body Mass Index and Blood Pressure of Adults of 30–50 Years of Age in Ghana. J Heal Res Rev. 4 (3):26–32. doi:10.4103/jhrr.jhrr
29. Tesfaye F, Nawi NG, Van Minh H, Byass P, Berhane Y, Bonita R, Wall S. Association between body mass index and blood pressure across three populations in Africa and Asia. J Hum Hypertens. 2007;21(1):28–37. doi:10.1038/sj.jhh.1002104.
30. Linderman GC, Lu J, Lu Y, Sun X, Xu W, Nasir K, Schulz W, Jiang L, Krumholz HM. Association of body mass index with blood pressure among 1.7 million Chinese adults. JAMA Netw open. 2018;1(4):e181271. doi:10.1001/jamanetworkopen.2018.1271.
31. Chen H, Zhang R, Zheng Q, Yan X, Wu S, Chen Y. 2018. Impact of body mass index on long-term blood pressure variability: A cross-sectional study in a cohort of Chinese adults. BMC Public Health. 18(1):1–8. doi:10.1186/s12889-018-6083-4
32. Mungreiphy NK, Kapoor S, Sinha R. Association between BMI, Blood Pressure, and Age: study among Tangkhul Naga Tribal Males of Northeast India. J Anthropol. 2011;2011:1–6. doi:10.1155/2011/748147.
33. Ravisankar P, Madanmohan UK, Prakash ES.Correlation between body mass index and blood pressure indices, handgrip strength and handgrip endurance in underweight, normal weight and overweight adolescents. Indian J Physiol Pharmacol. 2005;49 (4):455–61.
34. Rafiee E, Khaledi M, Madmoli M, Zafari M, Lotfizadeh M.The Correlation between Blood Pressure and BMI in Students of

Shahrekord University of Medical Sciences in 2013-14. Int J Ayurvedic Med. 2013;10(1):113–17.
35. Kaushik D, Chawla GK. Correlation between blood pressure and body mass index among University students. Int J Heal Sci Res. 2019;9(August):394–98.
36. Baygi F, Jensen OC, Qorbani M, Farshad A, Salehi SA, Mohammadi-Nasrabadi F, Asayesh H, Shidfar F. Prevalence and associated factors of cardio-metabolic risk factors in Iranian seafarers. Int Marit Health. 2016;67(2):59–65. doi:10.5603/IMH.2016.0013.
37. Hjarnoe L, Leppin A. 2014. A risky occupation? (Un)healthy lifestyle behaviors among Danish seafarers. Health Promot Int. 29 (4):720–29. doi:10.1093/heapro/dat024
38. Nittari G, Tomassoni D, Di Canio M, Traini E, Pirillo I, Minciacchi A, Amenta F. Overweight among seafarers working on board merchant ships. BMC Public Health. 2019;19:1.
39. Chobanian AV, Bakris GL, Black HR, Cushman WC, Green LA, Izzo JL Jr, Jones DW, Materson BJ, Oparil S, Wright JT Jr, et al. Seventh report of the joint national committee on prevention, detection, evaluation, and treatment of high blood pressure. Hypertension. 2003;42(6):1206–52. doi:10.1161/01.HYP.0000107251.49515.c2.
40. World Health Organization. *Obesity: preventing and managing the global epidemic report of a WHO consultation (WHO technical report series 894)*. 1999. [Accessed Aug 16, 2020]. https://www.who.int/nutrition/publications/obesity/WHO_TRS_894/en/
41. Hansen HL, Hjarnoe L, Jepsen JR.Obesity continues to be a major health risk for Danish seafarers and fishermen. Int Marit Heal. 2011;62(2):98–103.
42. Hoeyer JANL, Hansen HL. OBESITY AMONG DANISH SEAFARERS. Int Marit Heal. 2005;56:1–4.
43. Faghri PD, Mignano C, Huedo-Medina TBCM. 2015. Psychological health and overweight and obesity among high stressed work environments. Obes Open Access. 1(1):1–23. doi::10.16966/2380-5528.101
44. Wardle J, Steptoe A, Oliver G, Lipsey Z. Stress, dietary restraint and food intake. J Psychosom Res. 2000;48:195–202.
45. Kirk MA, Rhodes RE. 2011. Occupation correlates of adults' participation in leisure-time physical activity. Am J Prev Med. 40 (4):476–85. doi:10.1016/j.amepre.2010.12.015
46. Twisk JOSWR, Snel JAN, Kemper HANCG, Van MW. Changes in daily hassles and life events and the relationship with coronary heart disease risk factors : a 2-year longitudinal study in 27–29-year-old males and females. J Psychosom Res. 1999;46(3):229–40.
47. Wardle J, Chida Y, Gibson EL, Whitaker KL, Stress SA. 2009. Adiposity : A Meta-Analysis of Longitudinal Studies. Obesity. 19 (4):771–78. doi:10.1038/oby.2010.241
48. Caban AJ, Lee DJ, Fleming LE, Gómez-marín O, Leblanc W, Pitman T. 2005. Obesity in US workers : the national health interview survey, 1986 to 2002. Am J Public Health. 95(9):1614–22. doi:10.2105/AJPH.2004.050112
49. STCW. International convention on standards of training, certification and watchkeeping for seafarers. IMO. 1995. [Accessed 2020 May 2]. http://www.imo.org/en/OurWork/humanelement/trainingcertification/pages/stcw-convention.aspx
50. Oldenburg M, Jensen HJ, Latza U, Baur X. 2009. Seafaring stressors aboard merchant and passenger ships. Int J Public Health. 54 (2):96–105. doi:10.1007/s00038-009-7067-z
51. Chandola T, Brunner E, Marmot M. Chronic stress at work and the metabolic syndrome: prospective study. BMJ. 2006;80:1–5. doi:10.1136/bmj.38693.435301.80.