

# The risk of coronary heart disease of seafarers on vessels sailing under German flag

Marcus Oldenburg<sup>1</sup>, Hans-Joachim Jensen<sup>2</sup>, Ute Latza<sup>3</sup>, Xaver Baur<sup>1</sup>

<sup>1</sup>Department of Maritime Medicine, Hamburg Port Health Centre, Institute for Occupational Medicine and Maritime Medicine (ZfAM), University of Hamburg, Germany

<sup>2</sup>University of Applied Science, Flensburg, Germany

<sup>3</sup>Federal Institute for Occupational Safety and Health, Berlin, Germany

## ABSTRACT

**Background.** This study aimed to predict the risk of coronary heart disease (CHD) among seafarers on German-flagged vessels and to assess the association of shipboard job duration at sea with the risk of CHD.

**Material and methods.** During the legally required medical fitness test for nautical service, 161 seafarers in Hamburg participated in a cross-sectional study which included an interview, blood sampling, and blood pressure measurements (response 84.9%). The predicted 10-year risk of an acute coronary event of the examined German seafarers aged 35 to 64 years ( $n = 46$ ) was assessed in comparison with a sample of male German employees of the same age working ashore (PROCAM study). The number of independent CHD risk factors (according to the PROCAM study) was compared in the groups with 'shorter' and 'longer' median shipboard job duration at sea (15.0 years).

**Results.** The examined German seafarers had a similar age-standardized predicted 10-year CHD risk as the German reference population. Nearly all independent CHD risk factors were significantly more frequent in seamen with job duration at sea of  $\geq 15$  years than in those with  $< 15$  years. After adjusting for age, the number of CHD risk factors was associated with job duration (OR 1.08 [95% CI 1.02–1.14] per year).

**Conclusions.** Seafarers on German-flagged ships have to attend a medical fitness test for nautical service every 2 years. Thus, it can be assumed that seafarers present a healthier population than employees ashore. In this study, however, CHD risk of seafarers was similar to that of the reference population. This may indicate that working onboard implies a high coronary risk. Furthermore, the study results suggest a tendency of increased risk of CHD among seafarers with longer job duration at sea.

**Key words:** job duration, seafaring, coronary heart disease, German-flagged vessels

## INTRODUCTION

Levi et al. (2002) explored the mortality of myocardial infarction in several European countries, the USA, and Japan and found remarkable differences between the populations [1]. CHD risk depends on many fac-

tors. Based on large population-based prospective cohort studies, several scores were established to assess the coronary risk. Well-known risk scores were derived from the FRAMINGHAM study [2] and the Prospective Cardiovascular Münster (PROCAM) study [3].

✉ Dr. M. Oldenburg, Department of Maritime Medicine, Hamburg Port Health Centre, Institute for Occupational Medicine and Maritime Medicine (ZfAM), University of Hamburg, Germany, Seewartenstr. 10, D-20459 Hamburg, Germany. Tel: +49 40 428894508, fax: +49 40 428894514, e-mail: marcus.oldenburg@bsg.hamburg.de

The conditions of seamen and other working populations differ fundamentally, e.g. due to unusual working hours, monotony during long cruises, long separation from family and friends, and psychosocial problems due to multicultural crews [4]. According to Lane et al. (2002), more than 65% of the worldwide merchant fleet is manned by multinational crews [5].

In recent years the reduced number of crew members has resulted in an increased workload aboard [6]. Furthermore, the leisure time activities onboard are limited enforcing the feeling of isolation on the ship [7]. Due to the high level of psychosocial stress, many seafarers apply coping strategies during their long voyages – such as smoking and drinking alcohol. In a current cross-sectional study on 145 seamen (94 Europeans and 51 non-Europeans) aboard German-flagged vessels, differences in smoking habits were found dependent on the subjects' origin (Europeans vs. non-Europeans: 34.0% vs. 45.1% non-smokers; 21.3% vs. 13.7% former smokers and 44.7% vs. 41.2% current smokers; 4.5 vs. 0.2 pack years) [8].

There is a need to further investigate the prevalence of established CHD risk factors related to work-related psychosocial and organizational factors onboard. This study aimed first to compare the CHD risk of examined German seafarers with a sample of the German general population working ashore, and second to assess the impact of job duration at sea on the CHD risk of seamen onboard German-flagged vessels.

## MATERIALS AND METHODS

### STUDY POPULATION

According to the German ordinance on medical care on merchant ships, all seamen onboard German-flagged vessels have to attend a medical fitness test for nautical service. After informed consent, a total of 161 exclusively male seafarers with blood samples agreed to participate in this study (response 84.9%). At the time of the study, the 161 subjects with complete blood values were on average 41.5 years (SD 11.3 years) old.

As described elsewhere [9], the seafarers of 18 different nationalities were assigned to two groups (n in brackets):

**1. Europeans (104):** Germany (68), Poland (16), Russia/Ukraine (10), Croatia (2), Bulgaria (2), Lithuania (2), The Netherlands (2), Spain (1), Romania (1);

**2. Non-Europeans (57):** Myanmar (27), Kiribati (13), The Philippines (9), China (2), Cape Verde (2), Indonesia (1), Ghana (1), India (1), Chile (1).

### CLINICAL EXAMINATION

The weight and height of all seafarers were determined. According to WHO recommendations [10], body mass indexes between 25 kg/m<sup>2</sup> and 30 kg/m<sup>2</sup> and  $\geq 30$  kg/m<sup>2</sup> were defined as overweight and obese, respectively.

Furthermore, the blood pressure of the seafarers was measured by physicians or experienced medical staff. Arterial hypertension was defined as blood pressure  $\geq 140/90$  mm Hg and/or taking anti-hypertensive drugs.

Blood samples were analyzed for low-density lipoprotein (LDL) cholesterol and high-density lipoprotein (HDL) cholesterol, triglycerides, and glucose.

### QUESTIONNAIRE

In a standardized interview, the seafarers were asked about demographic and work-related data (job duration at sea) as well as potential CHD risk factors (smoking and history of myocardial infarction in first-degree relatives aged < 60 years). Based on the median job duration at sea (15.0 years), the seamen were assigned to the categories 'shorter' job duration (< 15 years) and 'longer' job duration ( $\geq 15$  years).

### ASSESSMENT OF CHD RISK

As the population of the PROCAM study consisted of German exclusively male employees aged between 35 and 64 years, this population was well suited as a reference population to our examined German seafarers (a sample of the total study group also aged between 35 and 64 years [n = 46]). The PROCAM score predicts the absolute 10-year risk of an acute coronary event. This event was defined as sudden cardiac death or fatal/non-fatal myocardial infarction.

The PROCAM risk score [3] identified eight 'independent' coronary risk factors (RF): age ( $\geq 45$  years), LDL cholesterol ( $\geq 160$  mg/dl), current smoker, HDL cholesterol ( $\leq 40$  mg/dl), blood pressure ( $\geq 140/90$  mm Hg and/or taking anti-hypertensive drugs), history of myocardial infarction in family members aged < 60 years, fasting glucose ( $\geq 110$  mg/dl and/or taking anti-diabetic drugs), and triglycerides ( $\geq 150$  mg/dl) (listed according to ranking). The PROCAM score was categorized in three score groups ( $\leq 44$ , 45–53, and  $\geq 54$ ), which were assumed to be related with a low (< 10%), moderate (10–20%), or high (> 20%) absolute risk to develop an acute coronary event within 10 years [3]. This predicted risk was compared

with the corresponding risk score of the PROCAM population working ashore.

Despite the different relevance of the individual RFs in various populations, it is assumed that CHD risk depends, independently of the study population, on the number of the generally approved RFs of the PROCAM study [11, 12]. Therefore, the different CHD risk factors (RF 0 to 8) were added without weighing their relevance, and the sum was used to estimate the coronary risk of the inhomogeneous 'total group' of examined seafarers ( $n = 161$ ). Seamen with less than 3 RFs ( $n = 106$ ) were regarded as a lower CHD risk group and those with at least 3 RFs ( $n = 55$ ) as a higher CHD risk group [9].

### STATISTICAL ANALYSIS

Odds ratio (OR) and 95% confidence intervals (CI) were estimated and linearly adjusted for age (years). All indicated  $p$ -values were two-sided, and an  $\alpha$ -value of  $< 0.05$  was regarded as statistically significant. Furthermore, the predicted CHD risk, independent of age, of German male seamen was calculated by direct standardization for age (age categories: 35–44, 45–54, and 55–64 years) on the basis of the PROCAM population.

## RESULTS

### PREDICTED RISK OF AN ACUTE CORONARY EVENT

In the examined study sample, 46 seafarers were German and aged from 35 to 64 years. The comparison of these 46 subjects with the PROCAM population revealed that the seafarers were older and smoked more. Furthermore, more subjects with diabetes were found in the examined study sample. LDL cholesterol was lower, but HDL cholesterol and triglycerides were considerably higher than in the PROCAM population (Table 1).

According to the three PROCAM score groups (risk  $< 10\%$ ,  $10\text{--}20\%$ , and  $> 20\%$ ), the frequency of risk score-based categories of an acute coronary event differed between the two populations. A predicted low CHD risk was less frequently found among German seafarers than in the reference population of PROCAM. Predicted moderate CHD risk was considerably more often observed in German seamen than in the PROCAM group, however. Only a few seafarers were found in the high risk group (risk  $> 20\%$ ). The predicted 10-year risk of an acute coronary event in the German seafarers examined, standardized to the PROCAM population, was similar to the predicted 10-year risk of

CHD of the German PROCAM population working ashore (Table 1).

### RELATIONSHIP OF CHD RISK AND JOB DURATION AT SEA

In the total study sample (161 seafarers), the CHD risk factors hypertension [49.7%], high triglycerides [41.6%], older age [39.8%], and smoking [37.3%] were most frequently found [13].

Based on the average job duration on board (15.0 years), the seamen were allocated to the categories 'shorter' and 'longer' job duration. After adjusting for age, seamen with a longer job duration at sea had a nearly threefold increased odds ratio to be in the group with  $> 2$  RFs.

Furthermore, nearly 75% of the seamen with longer job duration were Europeans. Overweight (body mass index between  $25 \text{ kg/m}^2$  and  $30 \text{ kg/m}^2$ ) was more frequently detected in seamen with a shorter job duration; obesity (body mass index  $\geq 30 \text{ kg/m}^2$ ), however, was less frequently found in this group by about 50%.

With the exception of diabetes, all independent risk factors according to Assmann et al. (2002) were significantly more pronounced in seamen with longer job duration than in those with shorter job duration (Table 2).

## DISCUSSION

Seafarer are exposed to a wide variety of work-related psychosocial factors that may increase the risk of CHD, such as frequent turnarounds in ports, reduced crew manning, lack of sleep, long separation from families, and high time pressure [6, 14, 15]. It is assumed that seafaring is an occupation with a high CHD risk [16–18]. Considerable differences of CHD risk exist between various nationalities [13]. In view of the known multinational crews on-board, the origin of the heterogeneous population groups has to be considered when estimating their coronary risk.

Considering the legally obligatory medical fitness test for nautical service every 2 years, a healthy worker effect is likely. In the framework of medical fitness tests, health disorders can be detected sooner to reduce the risk of their acute outbreak or manifestation at sea when on the spot professional help is scarcely available. Relating to CVD, the regular medical surveillance examination in Germany routinely includes the observation of the following independent coronary risk factors: smoking status, blood pressure, and urine-glucose. In obese seafarers

**Table 1.** Comparison of German seamen aged 35 to 64 years (n = 46) with the PROCAM population

	PROCAM population* (n = 5527)	German seamen (n = 46)
<b>Age (Y)</b> , median (min-max)	46.3 (35-64)	51.0 (35-63)
<b>Diabetes type II<sup>§</sup></b>	2.9%	8.7%
<b>Current Smokers</b>	33.8%	39.1%
<b>Family history of premature myocardial infarction</b>	16.3%	15.2%
<b>Laboratory findings [mg/dl]</b>		
LDL cholesterol, mean (SD)	148.5 (37.6)	126.5 (45.7)
HDL cholesterol, mean (SD)	45.5 (12.4)	57.2 (13.9)
Triglycerides, median (min-max)	130 (35-1970)	139 (46-415)
<b>Systolic blood pressure [mm Hg]</b> , mean (SD)	131.6 (18.4)	132.6 (14.7)
<b>Frequency of the score-based 10-year risk categories of an acute coronary event (%)</b>		
≤ 10% (score ≤ 44)	84.9%	71.7%
10-20 (score 45-53)	10.6%	23.9%
≥ 20% (score ≥ 54)	4.5%	4.3%
<b>Predicted risk rate of an acute coronary event in 10 years, (N/1000 subjects)</b>		
35-44 years	21	22
45-54 years	59	74
55-64 years	131	105
Total (standardized for age)	56	70 (57 <sup>#</sup> )

\*See: Hense et al. (2003) and after correspondence with the authors

<sup>§</sup>Glucose > 110 mg/dl and/or taking anti-diabetic drugs

<sup>#</sup>Standardized for age according to the PROCAM population

— depending on single-case decisions — ergometric tests are performed and blood samples are often taken to measure cholesterol, fasting glucose, and triglycerides as important coronary risk factors. Older seafarers (> 65 years) and those with a very high cardiac risk (high blood pressure) are obliged to attend fitness examinations at shorter intervals — e.g. every 6 months.

According to the annual report of the Seamen's Accident Prevention and Insurance Association, 1.6 in 1000 seafarers were declared unfit for nautical service due to CVD [19]. Additionally, seamen are regularly advised during the fitness test on how to reduce their CVD risk effectively. These facts support the statement that medical fitness tests can identify seafarers with extremely high coronary risk, can attribute to proper education and antihypertensive treatment, and can, if necessary, prohibit shipboard employment. The overall effect of the medical fitness test to reduce the seafarers' CVD risk (including the implications by individual CVD health counselling) can hardly be estimated.

In total, due to the regular medical fitness test for nautical service, a decreased CHD risk in German seamen as compared to a sample of the male working population was expected. Our study, however, revealed a similar 10-year risk of acute coronary event in the seamen as in the PROCAM reference population working ashore. This suggests that working aboard carries an increased coronary risk.

The present study showed that nearly 75% of the seamen working for more than 15 years at sea were Europeans. This is mainly due to the markedly better job and social security conditions for European seafarers than for non-European seafarers: in contrast to European seafarers with often unlimited contracts, the non-European seafarers normally have only short contract periods for their next shipboard stay of some months and must re-apply afterwards for a subsequent contract. Furthermore, the job competition in the large group of the often lower-qualified, non-European seamen is much more severe than among the European seamen.

**Table 2.** Selected characteristics of 161 seamen with shorter and longer job duration at sea (median 15.0 years)

	Seamen with		OR (95% CI)
	Job duration < 15 years (n = 80)	Job duration > 15 years (n = 81)	
<b>Higher CHD risk (<math>\geq 3</math> RF), n (% risk group)</b>	15 (18.8%)	40 (49.4%)	<b>2.73 (1.06–7.04)*</b>
<b>Group</b>			
European vs. non-European, n (% risk group)	44 (55.0%)	60 (74.1%)	<b>2.14 (1.01–4.55)*</b>
<b>Body mass index, mean (SD)</b>	26.2 (4.0)	27.3 (4.0)	<b>1.84 (1.16–2.93)*</b>
< 25 kg/m <sup>2</sup> , n (% risk group)	31 (38.8%)	28 (34.6%)	
$\geq 25$ – < 30 kg/m <sup>2</sup> , n (% risk group)	37 (46.2%)	30 (37.0%)	
$\geq 30$ kg/m <sup>2</sup> , n (% risk group)	12 (15.0%)	23 (28.4%)	
<b>Established coronary risk factors according to Assmann et al. (2002)</b>			
<b>Age (Y), mean (SD)</b>	33.8 (7.9)	49.2 (8.5)	<b>1.06 (1.02–1.09)</b>
<b>Diabetes mellitus type II, n (% risk group)<sup>§</sup></b>	1 (1.3%)	7 (8.6%)	1.26 (0.11–14.28)*
<b>Hypertension, n (% risk group)<sup>&amp;</sup></b>	35 (43.8%)	45 (55.6%)	<b>3.58 (1.73–7.37)*</b>
<b>Smoker, n (% risk group)</b>	27 (33.8%)	33 (40.7%)	<b>5.57 (2.52–12.33)*</b>
<b>Family history of premature myocardial infarction, n (% risk group)</b>	4 (5.0%)	10 (12.3%)	<b>12.17 (2.54–58.21)*</b>
<b>Laboratory findings (mg/dl)</b>			
LDL cholesterol, mean (SD)	109.6 (35.1)	133.9 (56.1)	<b>1.01 (1.00–1.02)*</b>
HDL cholesterol, mean (SD)	54.0 (14.5)	57.2 (15.0)	<b>0.97 (0.95–1.00)*</b>
Triglycerides, median (min–max)	103.5 (30–483)	145.0 (54–4362)	

Significant results are bold (CI does not include 1)

\*Odds ratio adjusted for age

<sup>§</sup>Glucose > 110 mg/dl and/or taking anti-diabetic drugs

<sup>&</sup>Blood pressure  $\geq 140/90$  mm Hg and/or taking anti-hypertensive drugs

RF = risk factor

In this study important CHD risk factors were hypertension, high triglycerides, and smoking. Although measuring blood pressure is currently already an important purpose of routine medical examination for nautical service, more attention should be paid to the seafarers' anti-hypertensive counselling in case of hypertension, on its appropriate treatment, and on respective follow-up examinations. Concerning the elevated triglycerides, the ship's-cooks should be trained in the preparation of low-fat diets. Moreover, other studies confirmed the currently observed high cigarette consumption of seafarers [9, 20–22]. The latter may be caused by the considerable work-related stress and the missing leisure time facilities aboard. Thus, smoking cessation programs and stress management courses should be offered for seafarers, e.g. during information events organized by the shipping companies or during the legally obligatory medical refresher courses for officers.

In this study the job duration at sea was significantly associated with the number of CHD risk factors after adjusting for age. Seafarers with longer job duration at sea had – independent of their higher age – significantly more frequently at least three coronary risk factors, according to Assmann et al. (2002), than those with shorter job duration. The average job duration at sea was 15 years in this study.

In a Polish study, seafarers of merchant ships had a mean experience of work at sea of 20.6 years [17]. In recent years the shipping companies have faced a problem of a lack of qualified new officers. As a consequence, seafarers at retirement age with longer shipboard job duration at sea are increasingly engaged on vessels. Due to the trend of increasing age among officers, it is expected that the CHD risk will increase in the following years.

It is a high-priority task of the maritime industry and shipping companies to raise the attractiveness of the seafaring occupation. A good way to do this is



a reduction of the stress load onboard in terms of primary prevention (e.g. improved watch-system, more balanced diet, or better offer of recreational activities on vessels). Field-studies on ships are necessary to explore the current living and working conditions of seamen. On the basis of such studies, the effect of interventions can be sufficiently assessed and suitable strategies can be developed regarding how to reduce CHD risk.

## REFERENCES

1. Levi F, Lucchini F, Negri E, La Vecchia C. Trends in mortality from cardiovascular and cerebrovascular diseases in Europe and other areas of the world. *Heart* 2002; 88: 119-124.
2. Anderson KM, Wilson PWF, Odell PM. An updated coronary risk profile: a statement for health professionals. *Circulation* 1991; 83: 356-362.
3. Assmann G, Cullen P, Schulte H. Simple scoring scheme for calculating the risk of acute coronary events based on the 10-year follow-up of the prospective cardiovascular Munster (PROCAM) study. *Circulation* 2002; 105: 310-315.
4. Wickramatillake HH, Barnes BL. Coronary heart disease deaths among British and Indian seafarers. *Seafarers Intern Res Centre (SIRC)* 1999; 1-47.
5. Lane AD, Obando-Rojas B, Wu B, Tasiran A. *Crewing the International Merchant Fleet, Lloyd's Register – Fairplay Ltd.* 2002.
6. Oldenburg M, Jensen HJ, Latza U, Baur X. Seafaring stressors aboard merchant and passenger ships. *Int J Public Health* 2009; 54: 1-10.
7. Oldenburg M. Isolation. *Maritime Occupational Medicine*. In: *Textbook of Maritime Medicine* <http://www.nfmm.no/tmm/maritime-occupational-medicine/11-7-isolation>. Accessed 10/06/2010.
8. Oldenburg M, Latza U, Baur X. Occupational health risks due to shipboard cockroaches. *Int Arch Occup Health* 2008; 81: 727-734.
9. Oldenburg M, Jensen HJ, Latza U, Baur X. Coronary risks among seafarers aboard German-flagged ships. *Int Arch Occup Environ Health* 2008; 81: 735-741.
10. WHO. Physical status: the use and interpretation of anthropometry. Report of a WHO Expert Committee. WHO Technical Report Series 854. Geneva: World Health Organization, 1995.
11. Grundy SM, Balady GJ, Criqui MH, Fletcher G, Greenland P et al. Primary prevention of coronary heart disease: guidance from FRAMINGHAM: a statement for health-care professionals from the AHA task force on risk reduction. *Circulation* 1998; 97: 1876-1887.
12. Menotti A, Keys A, Blackburn H, Kromhout D, Karvonen M et al. Comparison of multivariate predictive power of major risk factors for coronary heart diseases in different countries: results from eight nations of the Seven Countries Study, 25-year follow-up. *J Cardiovasc Risk* 1996; 3: 69-75.
13. Hense HW, Schulte H, Lowel H, Assmann G, Keil U. FRAMINGHAM risk function overestimates risk of coronary heart disease in men and women from Germany – results from the MONICA Augsburg and the PROCAM cohorts. *Eur Heart J* 2003; 24: 937-945.
14. Oldenburg M. *Cardiovascular diseases*. In: *Textbook of Maritime Medicine* <http://www.nfmm.no/tmm/18-welfare-on-board>. Accessed 10/06/2010.
15. Jezewska M, Leszczynska I, Jaremin B. Work-related stress at sea. Self-estimation by maritime students and officers. *Int Marit Health* 2006; 57: 66-75.
16. Tüchsen F, Andersen O, Costa G, Filakti H, Marmot MG. Occupation and ischemic heart disease in the European Community: a comparative study of occupations at potential high risk. *Am J Ind Med* 1996; 30: 407-414.
17. Jaremin B, Kotulak E. Myocardial infarction (MI) at the work-site among Polish seafarers. The risk and the impact of occupational factors. *Int Marit Health* 2003; 54: 26-39.
18. Ehara M, Muramatsu S, Sano Y, Takeda S, Hisamune S. The tendency of diseases among seamen during the last fifteen years in Japan. *Ind Health* 2006; 44: 155-160.
19. Annual report of the statutory insurance institution for seafaring [See-Berufsgenossenschaft; Schiffssicherheit: Jahresbericht 2008]; [http://www.bg-verkehr.de/service/downloads/dienststelle-schiffssicherheit/jahresberichte/Jahresbericht\\_2008\\_Internet.pdf](http://www.bg-verkehr.de/service/downloads/dienststelle-schiffssicherheit/jahresberichte/Jahresbericht_2008_Internet.pdf). Accessed 10/06/2010.
20. Kirkutis A, Norkiene S, Grieciene P et al. Prevalence of hypertension in Lithuanian mariners. *Proc West Pharmacol Soc* 2004; 47: 71-75.
21. Hansen HL, Jensen J. Female seafarers adopt the high risk lifestyle of male seafarers. *Occup Environ Med* 1998; 55: 49-51.
22. Parker AW, Hubinger LM, Green S, Sargeant L, Boyd R. A survey of the health, stress and fatigue of Australian seafarers. Australian Maritime Safety Authority: Canberra 1997.