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Cardiovascular risk factors in seamen and fishermen: review of literature

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ABSTRACT

Background and aim: *The aim of this study was to evaluate the prevalence of risk factors for cardiovascular disease among sailors and their evolution over time.*

Materials and methods: *This study is a review of the literature from Medline® database and the* Medicina Maritima *journal. With prevalence studies, the overall prevalence was calculated; 2 groups were created according to the study period (1990s vs. 2000s) and compared by χ^2 test with Mantel-Haenszel correction.*

Results: *Eighteen articles were selected (total: 57,473 European sailors and 327 non-European sailors). Smoking prevalence varied between 37.3 and 72.3%; overweight prevalence between 27.9 and 66.5%; hypertension was between 8.2 and 49.7%; hypercholesterolaemia ("high blood level of cholesterol") varied between 25.1 and 42% of the populations studied; between 3.3 and 9.3% of the populations studied suffered from diabetes. Two studies showed a 10-year cardiovascular risk comparable to that of the general population. After calculating with similar studies, the prevalences were 61.4% for smoking, 60.9% for overweight, 30.1% for hypertension, 34.6% for high cholesterol, and 3.6% for diabetes. Smoking prevalence was significantly lower in 2000s (45.4% vs. 61.3%, $p < 0.01$), those of overweight, hypertension and hypercholesterolaemia were higher (64.1% vs. 47.1%, $p < 0.01$, and 42.1% vs. 14.8%, $p < 0.01$, 42.0% vs. 33.9%, $p = 0.02$).*

Conclusions: *Modifiable risk factors are the most studied. Smoking tended to decrease in the 2000s.*

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Key words: occupational health, risk factors, ships, prevalence, review, maritime

INTRODUCTION

Sailors have a high prevalence of cardiovascular risk factors (CRF). This fact can be explained for example by their lifestyle (living in the closed areas, important place of food on board, etc.) [1]. As a result, sailors may have a risk of coronary heart disease (CHD). A 2008 study with 161 seamen, who were aboard ships under the German flag, showed after adjusting for age, that the number of CHD risk factors was associated with job duration (OR 1.08 [95% CI 1.02–1.14] per year) [2]. A study over the last 50 years in Japan showed that prevalence of circulatory system diseases was 11.6% on average for all types of sailing [3]. A study about cadiovascular disease mortality in Bristish merchant shipping between 1919 and 2005 showed a little decrease of trends in mortality rates among seafarers [4]. A study in years 1960–1999 concerning death causes on board of Polish vessels showed that circulatory diseases were the first internal cause of death [5]. Thus, a great number of mariners suffer from an acute coronary syndrome or myocardial infarction (MI) during travelling abroad [6]. The risk of fatal MI depends on time of advanced cardiac life support implementation [7].

The MI seems to be one of the leading causes of death among mariners [8, 9]. Moreover, these cardiac events can

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endanger other crew members, safety of the ship itself, and entail economic loss (lack of productivity, legal demands for recompensation). These situations require telemedicine [6]. The doctor, besides his preventative role, has to certify the death on board and try to determine the circumstances of it. He should be supported by a legal investigation if necessary [8].

Consequently, prevention seems to be important for this population. In order to ensure better targeting of the prevention, risk factors for mariners should be better understood. The purpose of this study was to assess the prevalence of various CRF in sailors.

MATERIALS AND METHODS

This study is a review of literature. The articles were sought from the medical database Medline® and from the *Medicina Maritima* journal. Research in English was done using key words: "Risk Factors" [Mesh]; "Cardiovascular Diseases" [Mesh]. The word "marine" and its various synonyms were then combined, one after the other, with each of the MESH key words; the algorithm "AND" was used. Research in French was done using key words: 'facteur de risque', 'cardiovasculaire', 'marins', 'pêcheurs'. Research in Spanish was done using key words: 'los factores de riesgo', 'cardiovascular', 'marino', 'pescador'. The inclusion criteria were as follows: primary or secondary objective was to study at least 1 CRF or was the study of predicted cardiovascular risk. Studies in the literature which primary or secondary objective was to study at least 1 CRF were included. The study of predictive cardiovascular risk was also included. Moreover, the selected articles had to be published between 1988 and 2013. Articles dealing with risk factors, but which did not include specifically sailors, were rejected. Further investigation was then carried out by analysing bibliographies of the previously selected articles.

From these data, risk factors considered were traditional ones: advanced age (> 55 years for men and > 65 years for women), high blood pressure, non-severe (treated or untreated) high cholesterol (HCT), diabetes, smoking [10, 11]. All other risk factors cited in the articles: left ventricular hypertrophy, lack of physical activity, family history in particular. The analysis also sought protective factors in the articles: physical activity and food (fruits and vegetables).

For the prevalence studies, if the definition of 1 CRF was the same in different papers, a calculation of overall prevalence rate was achieved for this CRF. If a few papers studied the same population, this population was included only once in the calculation.

In addition, among comparable studies, 2 groups were created according to the study period (1990s vs. 2000s). These groups were compared by χ^2 test with Mantel-Haenszel correction to assess changes over time in the prevalence of CRF.

To make reading easier, we choose to use only the word "mariner".

RESULTS

SELECTED STUDIES

Eighteen articles intended to study CRF: 12 cross-sectional studies, 3 retrospective studies, 2 cohort studies and 1 case report [2, 12–31]. All in all, the risk factors were studied for 57,473 European mariners (Spanish, German, Polish and Lithuanian) and 327 non-European mariners (Indonesian and others). In addition, a Spanish study with 134,219 subjects was used for smoking. Moreover, the Canals-Pol study was taken into account separately because it consisted of subjects already included in other studies [12].

On all of these articles, 2 studies were designed to calculate the predictive risk of acute coronary events. These were a study of 161 sailors under the German flag [2, 13, 31] and a study comparing the Framingham score between the mariners and workers on the ground in Indonesia [15]. Oldenburg et al. [2] could calculate the risk for only 46 of the German mariners. Both studies showed a 10-year cardiovascular risk comparable to that of the general population. Oldenburg et al. [31] showed that CRFs were significantly more often seen in seamen with job duration ≥ 15 years. Number of CRFs was associated with job duration (OR = 1.08, 95% CI: 1.02–1.14 per year).

With regard to the prevalence, 5 studies, which were conducted in 1990s, and 7 studies, which were conducted in years 2000 and 2010, were selected (Table 1). Indeed, other studies focused on specific populations: sailors who had MI or mariners with overweight [7, 16–19]. Similarly, the case report did not allow to obtain epidemiological evidence [20].

RISK FACTORS

Canals-Pol showed that 61% of mariners smoked between 1993 and 1998. It was a study of 134,219 Spanish mariners made between 1993 and 1998; it studied addictive behaviour of these sailors. This was a retrospective study using data from consultations with mariners. The sole CRF taken into account was then smoking [12]. For other studies, smoking prevalence varied between 37.3% and 72.3% [2, 12, 13, 21, 23, 24, 26, 28, 30]. Total cholesterol was measured in most articles [15, 21, 23, 24]. Three studies measured other lipid parameters [2, 15, 21]. Balanza Galindo [21] showed that 4.3% of mariners had low HDL-cholesterolaemia (< 35 mg/dL) and that 9.5% had high triglyceridaemia (> 200 mg/dL). Oldenburg et al. [2] showed that 41.6% of mariners had high triglyceridaemia (> 150 mg/dL).

Table 1. Studies for prevalence calculation

Study	Type of study	Aim	Sample	Method
Klitz et al.	Sectional study 1990	Detect coronary disease	50 Polish men, average age 41.5 years	Clincal examination cardiac stress testing
Tomaszewski et al.	Sectional study 1990	Quantify the risk of ischaemic heart disease	480 fishermen, 980 seamen, 500 dockers	Clinical examination cardiac stress testing and electrocardiogram; heart echography; chest X-ray; laboratory test
Canals--Pol-Lina	Retrospective study Maritime medical data of Spain 1993–1998	Investigate the prevalence of addictive behaviour	134,219 mariners	Data of reglementary medical examination
Balanza Galindo	Sectional study 1996	Study the alcohol consumption and cardiovascular risk factors	485 mariners	Clinical examination; laboratory test
Tristancho	Retrospective study Maritime medical data of Spain 1998–2000	Study the prevalence of diabetes and obesity	49,022 mariners	Clinical examination; laboratory test
Purnawarma	Sectional study 2010	Study the cardiovascular risk factors and calculate cardiovascular risk	348 Indonesian men = 212 seamen + 136 land workers	Clinical examination; laboratory test; Framingham score
Jan	Sectional study 2005	Study the prevalence of obesity	1,257 seamen	Clinical examination
Fort	Sectional study 2009	Study the prevalence of tobacco and alcohol consumption	1,847 French seamen and women	Questionnaire
Frantzeskou	Sectinal study 2012	Risk factors	100 seamen and women	Questionnaire
Hansen	Sectional study 2001–2011	Study the prevalence of obesity	2,101 Danish seamen	Clinical examination
Oldenburg	Sectional study 2006 and 2010	Study the cardiovascular risk factors and calculate cardiovascular risk	161 male seamen, 46 German mariners	Clinical examination; laboratory test; PROCAM score
Kirkutis	Sectional study	Study the prevalence of hypertension, overweight and smoking	1,135 male seamen of Lithuania	Clinical examination

LDL-cholesterol was measured in 2 studies: Oldenburg et al. [2] and Purnawarma et al. [15] (> 160 mg/dL for both studies). There were 18% and 26.6% of mariners with high LDL-cholesterol respectively.

Glycaemic abnormalities were defined in the articles in different ways. Two items studied the prevalence of diabetes, while other measured glycaemia. Oldenburg et al. [2] found that 5% of the sailors had diabetes; Purnawarma et al. [15] found 3.3%. Hyperglycaemia standards differed between different studies: 1.26 g/L or 1.2 g/L [21, 22]. Some articles studied fasting blood glucose concentration (Table 2) [27, 28].

Sometimes family histories were studied: a study showed this risk factors for 8.7% of the sailors [2, 13]. However, the risk factor was considered to be present only if a coronary episode took place before the age of 60 for one of parents [2, 13].

Left ventricular hypertrophy was studied in the article of Tomaszewski et al. [24]. The authors studied prevalence in risk groups: 8.4% and 6% of fishermen and mariners respectively. By taking these figures, calculated prevalences for the total population of each of these 2 categories of workers from sea were therefore 2.1% and 1.6% for fishermen and mariners respectively. So, the prevalence for all persons working at sea was 1.7%.

Age differed across the studies. Oldenburg et al. [2, 13] showed that 39.8% of the mariners had more than 45 years. For Purnawarma et al. [15], 77.5% of the mariners had more than 45 years and 59.9% had more than 50 years.

The study of Filikowski et al. [25] examined the accumulation of CRF. They found 30.5% of mariners with 1 factor, 50.3% with 2 factors, 13.2% with 3 factors, and 6% with 4 or more factors. Oldenburg et al. [13] found that 34.2% of subjects had at least 3 CRF. On the other side, they showed

Table 2. Prevalence of risk factors

	Klitz	Tomaszewski		Canals--Pol-Lina	Balanza Galindo	Tristancho	Purna-warma	Jan	Fort	Frantze-skou	Hansen	Oldenburg	Kirkutis
		Fishermen	Seamen										
Tobacco consumption	26% (13)	41.2% (198) > 20 cigarettes/day	39.8% (378) > 20 cigarettes/day	61% (81,873)	72.3% (351)		47.6% (101)		44.9% (830)	40% (40)		37.3% (60)	55.2% (627)
Overweight; obesity	34% (17) BMI > 25	27.9% (134) BMI > 25	57.5% (546) BMI > 25			21.3% (10,445) BMI > 30	53.8% (114) BMI > 25	64% (1,257) BMI > 25			66% (1,379) BMI > 25	63.4% (102) BMI > 25 21.7% (35) BMI > 30	66.5% (755)
HBP > 140 and/or 90 mm Hg	6% (3)	8.2% (39)	14% (133)		23.7% (115)		21.2% (45)					49,7% (80)	44.9% (510)
HCT	42% (21) > 250 mg/dL	43.3% (208) > 250 mg/dL	25.1% (238) > 250 mg/dL		41.2% (200) > 240 mg/dL		42% (89)						
CST	42% (21)	34.5% with risk group	42% with risk group										
Glycaemic abnormalities		10.6% (51) fasting blood glucose concentration	12.5% (119) fasting blood glucose concentration		9.3% (45) > 1.26 g/L	3.6% (1,780) > 1.20 g/L							
Diabetes							3.3% (7)					5% (8)	

BMI — body mass index; CST — cardiac stress testing; HBP — high blood pressure; HCT — high cholesterol

Table 3. Calculated prevalence of risk factors for this literature review and comparison of prevalence during 1990s and 2000s

Risk factors	Prevalence	1990s studies prevalence	2000s studies prevalence	p
Tobacco consumption	61.4% (84,458)	61.3% (82,237)	45.4% (1,567)	< 0.01
Overweight; obesity; BMI > 25	60.9% (3835)	47.1% (697)	64.1% (3,120)	< 0.01
HBP > 140 and/or 90 mm Hg	30.1% (925)	14.8% (290)	42.1% (635)	< 0.01
HCT	34.6% (735)	33.9% (667)	42% (89)	0.02
Glycaemic abnormalities or diabetes	3.6% (1,795)	3.9% (1,995)	4.0% (15)	0.92

BMI — body mass index; HBP — high blood pressure; HCT — high cholesterol

that the number of CHD risk factors was associated with job duration (OR 1.08 [95% CI 1.02–1.14] per year) [2].

Protective factors were studied sometimes. Daily consumption of fruits and vegetables was reported for 66% and 68% of mariners, respectively [26]. The same study of 100 Greek mariners, including 13 women, found that 34% of mariners practiced physical activity. Another study showed that 88.2% of mariners lacked physical activity [15].

OVERALL PREVALENCE AND ITS EVOLUTION BETWEEN 1990S AND 2000S

In total, there were 84,458 (61.4%) smokers (Table 3). Number of mariners with overweight was 3,835 (60.9%). However, studies which examined only those subjects with body mass index (BMI) > 30 have not been taken into account. Total hypercholesterolaemia was found in 34.6% of mariners. Nevertheless, this group includes studies with slightly different criteria. Indeed, the Balanza Galindo's study [21] considered mariners with total cholesterol over 240 mg/dL, while other considered the subjects with total cholesterol over 250 mg/dL. There is, hence, an underestimation of the prevalence of sailors with total cholesterol greater than 240 mg/dL.

Comparing the prevalence between 1990s and 2000s, smoking prevalence was significantly lower in 2000s. However, the prevalence of overweight, of hypertension and hypercholesterolaemia was higher in the 2000s (Table 3).

DISCUSSION

In this literature review, it appeared that few studies have exhaustively documented the CRF of mariners. Only 2 studies calculated the predictive risk of acute coronary event. The main risk factor was smoking (overall prevalence of 61.4%). Then came the overweight (BMI > 25) and HCT (respectively 60.9% and 34.6%). When the prevalences between 1990s and 2000s were compared, only smoking prevalence tended to decrease.

The strength of this study was to select the items from several databases and work in multiple languages. Consequently, items not listed in Medline were considered and included. It appeared that Hispanics have worked a lot on this, so that a third of information available in early 2013 was not available in Medline. The other highlight was to include studies from 1990s, thus providing information on a large number of sailors, and information to evaluate the evolution of prevalence.

It could, however, be argued that the way of calculating the overall prevalence was biased. Indeed, it would be possible to have the same subject several times in the calculations — this possibility was taken into account. Articles with the same people were counted only once. This was particularly the case for the study of Oldenburg et al. [2, 13], or, for example, the Filikowski et al. article [25], which data have been included in the Hansen et al. study [29]. Also, its data were not included in the calculations of our study. Similarly, 2 Spanish studies included probably some mariners in common [12, 21]. Indeed, the study of Canals-Pol included all Spanish sailors until 1998 and Galindo Balanza's study included nearly half Spanish mariners since 1998. However, 2 studies did not assess the same risk factors. As a result, the probability that 1 subject has been included in several studies appears low. Nevertheless, the overall prevalence study was an approximation for 2 risk factors: HCT and glycaemic abnormalities. Regarding high cholesterol, definitions differed from one study to another, or between > 240 mg/dL or > 250 mg/dL [15, 21, 23, 24]. It was considered that the calculation was still interesting. The overall prevalence of HCT underestimated the prevalence of subject with a total cholesterol > 240 mg/dL. For glycaemic abnormalities, definitions were very heterogeneous. It would have been interesting to know the prevalence of diabetes [32].

The prevalence of smoking is important to be considered, as the INTERHEART study showed an odds ratio of cardiovascular disease of 2.95 for smokers [33]. Meanwhile, it has been shown that the combination of risk factors is a risk factor. The presence of more than 3 risk factors is associated with an odds ratio of 1.5 [34]. If several studies were documenting the CRF of mariners, few studies assessed the number of subjects with several risk factors. For example, Filikowski et al. [25] showed that 13.2% of subjects had at least 3 CRF. In addition, few studies have focused on risk factors such as family history or age. For the studies analysing

this data, their definitions of age as a CRF were different. However, advanced age is a known risk factor if age is > 55 years for men and > 65 years for women [10]; furthermore, a recent study has shown that cardiac incidents occur more often in patients over 43 years of age [35]. In contrast, some protective factors, particularly physical activity, were rarely studied, even if it is shown that physical activity and diet rich in vegetables decrease cardiovascular risk [10, 34, 36]. Thus, probably it would be interesting to develop a future study analysing all risk and protective factors. However, the identification of risk factors remains a limited approach. In fact, 20% of people with MI had no CRF [37].

The most recent studies assessed for the predictive risk [2, 15]. These approaches were based on the latest scientific data and were not accessible to the older studies. It should be noted, however, that the maritime world has a limit in choosing the method to be used. Indeed, the predictive risk is calculated in different ways, depending on the geographical origin of the subjects. And the Framingham score is more suited to the North American population. The SCORE risk study is more suited to the European population, and PROCAM score is more suited to the German population [38–41]. Nevertheless, mariners on the same ship are often from different countries. For example, Oldenburg et al. studied 161 mariners and calculated predictive risk for 46 German mariners only. Accordingly, it would be interesting that future study may incorporate this parameter and select several tools depending on the geographical origin of the subjects. A recent study has also used this method to examine the risk in professional divers: 81% of divers had at least 1 risk factor and 2.5% had high cardiovascular risk at 10 years [11].

Several articles in the literature dealt with another CRF — occupational stress [42, 43]. Indeed, a meta-analysis showed that job strain is associated with the risk of MI [44]. However, this risk factor was not included in any study of CRF among mariners. Given the evolution of scientific data, a future study should be able to take job strain into consideration.

Little data in the literature focused on primary prevention. A Canals-Pol article dealt with the impact of risk factors on the maritime ability from a case report [12]. Another article studied the feasibility of ultrasound screening in the occupational medicine [45]. It seems legitimate — considering the health impact on mariners [46] — that this issue is the subject of evaluation of prevention campaigns. For introducing such methods of prevention, good cooperation with the ship owner is essential [47]. It would be interesting to assess, for this population, which technique of primary prevention is the most effective one. In contrast, several articles studied secondary prevention; in particular, considered the effectiveness of telemedicine. A retrospective study about the French TeleMedical Assistance Service showed 179 cases of cardiovascular disease between 01/01/2008 and 12/31/2009: 79 passengers and 89 professional seamen. The professional seamen had more from chest pain than passengers ($p < 0.01$), and passengers had more pulmonary oedema ($p = 0.05$). The main CRF was smoking (22.3%) [48]. Other method of secondary prevention is the implementation of external defibrillators. This is important, because the prognosis is related to time response [49]. A study of Oldenburg et al. [50] suggested that most trained lay rescuers can use conventional external defibrillators effectively for the electrocardiography transmission. In another study, the authors concluded that the ship management has to observe practical questions of storage, maintenance, signing, training, data management, and transmission [51].

CONCLUSIONS

This literature review has identified epidemiological data on CRF of mariners. The modifiable risk factors were the most studied. Smoking, overweight and hypercholesterolaemia were the main risk factors. Given the high prevalence of risk factors, a study assessing the impact of primary prevention programs would be interesting.

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