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Mortality Among Danish Merchant Seamen From 1970 to 1985

L.P.A. Brandt, MD, PhD, N.U. Kirk, MD, O.C. Jensen, MD, and H.L. Hansen, MD

A retrospective cohort study was performed to analyze the mortality patterns of Danish merchant seamen in the period 1970-1985. The population census in 1970 in Denmark was the source of information on individual occupation, age, and marital status. All men aged 20-64 years and economically active in 1970 were included. Computerized linkage with the Danish Mortality Register gave information about the deceased persons' date and cause of death. An increased overall mortality among all groups of seamen was found, being highest for deck and engine crew members. The overall mortality was strongly dependent on age and marital status. The highest mortality rate ratios (MRR) were found among young seamen and unmarried seamen. MRRs of 1.90 and 2.47 for cancer of the respiratory system were found among engine officers and crew. The MRRs for accidents and suicide were increased for all seamen, and were highest for crew members, among whom the MRR from accidents was stable within age groups but fell for suicide with increasing age. The same pattern was found with cirrhosis of the liver, although this was positively associated with increasing age. Excess mortality from ischemic heart disease was only found among engine crew (MRR = 1.43). This study confirms earlier findings of high mortality among seafarers. Negative selection into the occupation, occupational environmental factors, and lack of health and safety promotion programs and education could be causes of the high mortality. © 1994 Wiley-Liss, Inc.

Key words: occupational mortality, respiratory cancer, cardiovascular disease, cirrhosis of the liver, accidents, epidemiology, merchant mariners, seamen

INTRODUCTION

Mortality statistics from several countries have shown an increased overall mortality among seafarers compared to the population ashore [Vuksanovic and Goethe, 1986]. It is believed, though not well documented, that the high mortality can be explained by the occupational environment, the social conditions characterizing seafaring, the social features prevailing among the persons selected into the occupation, and the lack of adequate medical resources on board ships [Otterland, 1960]. Otterland found a twofold increased overall mortality among Swedish seafarers in the period 1945-1954, highest among young seafarers and crew members, primarily due to accidents and suicide. The same high mortality among seamen was

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found in an occupational mortality study in the Nordic countries [Nordisk Statistisk Sekretariat, 1988].

It has been indicated that the most important cause of accidents on board ships is human failure, rather than technical or operational failure [Vuksanovic et al., 1991]. A recent Swedish study concluded that 44% of deaths due to accidents among seafarers were work-related [Larsson and Lindquist, 1992]. Four studies have reported increased lung cancer mortality ratios from 1.42 to 2.10 among seamen [Kelman and Kavalier, 1990; Baksaas et al., 1983; Rapiti et al., 1992; Morabia et al., 1992], and another study showed a standardized mortality ratio (SMR) of 2.05 for lung cancer among marine engineers and machinists [Rafnsson et al., 1988]. In a study involving Norwegian tankers, increased risk for lung cancer was only found among seamen on oil tankers [Moen et al., 1990].

Otterland [1960] found a slightly increased mortality rate for cardiovascular diseases (CVD), and in another Swedish study the relative risk for myocardial infarction among deck officers was found to be 1.9 [Hammar et al., 1992]. Two studies among sea pilots in Germany and England both showed an increased mortality from CVD. Job stress was suggested as a risk factor [Zorn et al., 1977; Harrington, 1972]. However, a study among Swedish sea pilots and boatmen failed to find excess mortality from CVD or ischemic heart disease (IHD) [Nystrom et al., 1990], and in a Danish nationwide study based on hospital admission data, no increased morbidity from IHD was found among deck officers, but this was slightly increased for engine officers [Tuchsen and Bach, 1992].

This paper presents the results of a register based cohort study of mortality among Danish seafarers from 1970 to 1985, with special attention to the association between mortality, age, duties on board, and marital status.

METHODS AND MATERIALS

The 1970 Population and Housing Census in Denmark was used to establish the study population, giving information on sex, age, marital status, education, economic status, industry, and individual occupation. All men aged 20–64 year and economically active in 1970 were included as the reference population, and the cohort of seamen identified, including persons at sick-leave or occasionally unemployed at the census date. A 15 year follow-up from 1970 to 1985 was formed by means of computerized linkage with the Danish Mortality Register, providing information on deceased persons' date and causes of death during the follow-up period. The key to identification was the Central Person Identification Number, as all citizens in Denmark are identified by this number in all public registers, including those of health services. The mortality register is based on certificates of death and includes all Danish citizens. In the follow-up period, information on all emigration or disappearance for the census population during the follow-up period was obtained from the Central Population Register. Person years at risk were from November 9, 1970 until death, emigration, disappearance, or November 8, 1985, whichever came first. Diagnoses were registered according to the International Classification of Diseases, 8th revision (ICD 8).

Included in all causes of death were deaths without information on causes. Causes of death were grouped into main and subgroups of diseases and some selected single diagnoses in accordance with ICD 8. Mortality rate ratios (MRR) were calcu-

lated for deck officers and crew, and engine officers and crew, using all men 20–65 years old and economically active at the date of the census as the reference population.

Information about number of deaths and person years was given in three 5-year periods: 1970–1974, 1975–1979, and 1980–1985. Within each 5-year period, the study population was grouped in three age groups, namely, 20–34, 35–49, and 50–65 years, that is, age group cohorts were used rather than birth cohorts. Adjusted MRRs were calculated by means of stratified analyzes (direct pooling), i.e., Mantel-Haenzel weighted average of the stratum-specific MRRs, where the MRR in each stratum was weighted with the inverse of the stratum specific variance [Rothman, 1986]. Stratum-specific MRRs are kept in presentation of the results if effect modifications were found. Approximate 95% confidence intervals (CI) for directly weighted point estimates were calculated [Rothman, 1986].

RESULTS

In total 1,292,337 men were enrolled, accumulating 16,823,604 person years and 116,368 deaths. The corresponding figures for the deck officers were 3,906 persons, 50,542 person years, and 395 deaths; for the deck crew 5,646 persons, 74,228 person years, and 594 deaths; for the engine officers 3,442 persons, 45,426 person years, and 340 deaths; and for the engine crew 977 persons, 11,901 person years, and 174 deaths. Number of seafarers registered by the Danish Seafarers Tax Office in August 1970 were 2,804 deck officers, 4,088 deck crew members, 2,954 engine officers, and 840 engine crew members [Danmarks Statistik, 1972].

Table I shows mortality rates (MR) and number of deaths among the seafarers and the reference population from all causes of death and major groups of diseases. In a remarkably high number of deaths among seamen, no information was available about the cause of death (Table I); however, the MRs decreased during the three 5-year periods (Table II).

Tables III–VII show the MRR from all causes of death and the MRR from specific causes of death for deck officers and crew, and engine officers and crew, respectively.

We found an increased MRR from all causes for every group of seamen and a clear tendency toward decreasing MRRs from all causes with increasing age. Furthermore, the overall mortality was affected by marital status, most predominantly among deck officers and crew, among whom we observed no excess overall mortality for the married, aged 35–64 years (Table VIII).

Tables III–VII also show that the overall mortality was highest for crew members. Crew members had approximately a threefold increased mortality from accidents, independent of age. The only group who had no excess mortality from accidents was deck officers 50–64 years old. Mortality from suicide was high among and young seamen and highest among crew members. There was an excess cancer mortality among engine crew and officers, primarily from cancer in respiratory organs (Tables V–VII). We found no increased mortality from CVD (Table IV) or IHD (Table VII) among deck officers, only among engine crew (Tables VI and VII).

High mortality from “other diseases” was found among crew members, but not among officers. However, mortality from cirrhosis of the liver, which was included in “other diseases,” was increased, even among deck officers (Table VII).

TABLE I. Mortality Rates (MR) and Observed Number of Deaths (N) Among Danish Seamen 1970-85

Cause of death (ICD 8 codes)	Deck officers		Deck crew		Engine officers		Engine crew		Reference group	
	MR	N	MR	N	MR	N	MR	N	MR	N
All causes	78.2	395	80.0	594	74.8	340	146.2	174	69.2	116,368
Cancer (140-209)	20.6	104	14.8	110	20.7	94	34.5	41	20.4	34,280
Cancer respiratory organs (160-163)	7.5	38	4.8	36	9.2	42	18.5	22	7.3	12,255
Cancer digestive organs (150-159)	4.7	24	4.6	34	5.7	24	6.7	8	5.9	9,992
Cardiovascular diseases (390-458)	23.3	118	19.1	142	21.8	99	38.7	46	27.9	46,916
Ischemic heart diseases (410-414)	17.8	90	14.3	106	15.6	71	31.1	37	21.2	35,674
Accidents (E800-E999 exclusive of E950-E959)	5.7	29	11.9	88	5.7	26	10.9	13	4.3	7,181
Suicide (E950-E959)	4.6	23	7.1	53	4.0	18	5.9	7	4.3	7,266
Other diseases (000-136, 210-389, 460-796)	8.5	43	19.0	141	10.6	48	43.7	52	11.4	19,162
Cirrhosis of the liver (571)	3.0	15	5.5	41	2.2	10	9.2	11	1.8	3,051
No information	15.4	78	8.1	60	12.1	55	12.6	15	0.9	1,563

Reference group = all men economically active 1970 and aged 20-65 years; ICD 8 = International Classification of Diseases, 8th revision; MR = mortality rate = number of deaths per 10,000 person years; N = number of observed deaths.

TABLE II. Mortality Rates From Deaths Without Information on Causes Among Danish Seamen During the Three 5 Year Periods: 1970-74, 1975-79, and 1980-85

Duties on board	Mortality rates (deaths per 10,000 person years)		
	1970-74	1975-79	1980-85
Deck officers	22.2	14.8	7.5
Deck crew	13.3	4.9	5.3
Engine officers	15.0	11.9	8.8
Engine crew	10.6	23.2	3.0

DISCUSSION

The study gives information on mortality patterns in a 15 year follow-up for a cohort established by cross-sectional information on occupation in 1970. The difference between the number of seafarers included in this study and the number of seafarers registered by the Danish Seafarers Tax Offices can be explained by the fact that seafarers in domestic and coastal sea transport do not pay tax in accordance with the special seafarers tax system, and for the same reason they are not registered with the Danish Seafarers Tax Office [Danmarks Statistik, 1972]. Table II shows decreasing mortality rates from deaths without information on causes during the three 5-year periods, and it is very likely that this is due to selection out of seafaring within the

TABLE III. Mortality Rate Ratios (MRR) From All Causes of Death and Main Groups of Diseases Among Danish Deck Crew 1970-85

Causes of death	Age groups					
	20-34 years		35-49 years		50-64 years	
	MRR (95% CI)	N	MRR (95% CI)	N	MRR (95% CI)	N
All causes	2.91 (2.43-3.49)	124	1.79 (1.54-2.07)	185	1.45 (1.28-1.63)	285
Cancer	1.07 (0.47-2.33)	7	1.10 (0.74-1.63)	27	1.20 (0.95-1.52)	76
Cardiovascular diseases	1.22 (0.45-3.05)	5	1.21 (0.89-1.65)	40	1.10 (0.89-1.35)	97
Accidents	2.63 (1.91-3.62)	41	2.67 (1.79-3.96)	27	3.41 (2.14-5.38)	20
Suicide	2.67 (1.69-4.17)	21	1.54 (0.98-2.40)	21	1.63 (0.85-3.01)	11
Other diseases	2.84 (1.75-4.55)	19	2.73 (2.06-3.56)	54	2.19 (1.71-2.80)	68

Controlled for marital status and follow-up periods.
CI, confidence interval; N = number of deaths.

TABLE IV. Mortality Rate Ratios (MRR) From All Causes of Death and Main Groups of Diseases Among Danish Deck Officers 1970-85

Causes of death	Age groups					
	20-34 years		35-49 years		50-64 years	
	MRR (95% CI)	N	MRR (95% CI)	N	MRR (95% CI)	N
All causes	1.34 (0.86-2.07)	20	1.58 (1.34-1.86)	142	1.01 (0.89-1.15)	233
Cancer	0.44 (0.07-2.93)	1	1.36 (0.94-1.95)	29	1.00 (0.99-1.01)	74
Cardiovascular diseases	1.39 (0.35-5.54)	2	0.90 (0.62-1.33)	26	0.87 (0.71-1.07)	90
Accidents	1.28 (0.56-2.76)	7	1.71 (0.99-2.89)	15	1.02 (0.45-2.20)	7
Suicide	1.08 (0.28-3.46)	3	1.43 (0.83-2.35)	17	0.38 (0.10-1.21)	3
Other diseases	—	0	0.75 (0.44-1.30)	13	0.82 (0.58-1.18)	30

Controlled for marital status and follow-up periods.
CI, confidence interval; N = number of deaths.

follow-up period. In the analyses, however, person years at risk as seafarer were set to be 15 years or until death, disappearance, or emigration within the follow-up period. This might lead to underestimations of MRRs from diseases, which may have been caused by cumulative exposures specific to seafaring, for example, underestimation of death from cancer in the respiratory organs caused by exposure to carcinogens in engine rooms.

TABLE V. Mortality Rate Ratios (MRR) From All Causes of Death and Main Groups of Diseases Among Danish Engine Officers 1970-85

Causes of death	Age groups					
	20-34 years		35-49 years		50-64 years	
	MRR (95% CI)	N	MRR (95% CI)	N	MRR (95% CI)	N
All causes	1.88 (1.39-2.56)	40	1.74 (1.46-2.07)	128	1.24 (1.07-1.44)	172
Cancer	1.54 (0.64-3.68)	5	1.66 (1.16-2.38)	29	1.35 (1.05-1.74)	60
Cardiovascular diseases	1.47 (0.48-4.54)	3	1.36 (0.96-1.92)	32	1.03 (0.81-1.32)	64
Accidents	0.77 (0.31-1.78)	6	1.81 (1.00-3.18)	13	1.70 (0.74-3.67)	7
Suicide	2.40 (0.94-4.20)	8	0.72 (0.32-1.56)	7	0.63 (0.16-2.01)	3
Other diseases	0.90 (0.29-2.79)	3	1.02 (0.76-1.36)	18	1.24 (0.85-1.80)	27

Controlled for marital status and follow-up periods.
CI, confidence interval; N = number of deaths.

TABLE VI. Mortality Rate Ratios (MRR) From All Causes of Death and Main Groups of Diseases Among Danish Engine Crew 1970-85

Causes of death	Age groups					
	20-34 years		35-49 years		50-64 years	
	MRR (95% CI)	N	MRR (95% CI)	N	MRR (95% CI)	N
All causes	3.46 (1.87-6.24)	12	2.42 (1.79-3.26)	46	1.84 (1.52-2.22)	116
Cancer	—	0	1.67 (0.73-3.61)	7	1.69 (1.19-2.39)	34
Cardiovascular diseases	3.07 (0.16-20.01)	1	1.48 (0.72-2.91)	9	1.45 (1.05-2.00)	36
Accidents	2.31 (0.60-7.38)	3	3.23 (1.31-7.42)	6	2.13 (0.68-5.86)	4
Suicide	3.05 (0.76-12.20)	2	1.59 (0.51-4.39)	4	0.46 (0.02-3.00)	1
Other diseases	7.60 (2.43-20.98)	4	4.40 (2.60-7.33)	16	3.25 (2.26-4.66)	32

Controlled for marital status and follow-up periods.
CI, confidence interval; N = number of deaths.

Danish citizens deceased in foreign countries have usually been registered without information on cause of death. This practice accounts for the major part of deaths without information on cause. Deaths on board a Danish ship, no matter where it is situated, are regarded as deaths within Denmark. Nevertheless, an unknown number of deaths with diagnosed causes have been registered without this information be-

TABLE VII. Mortality Rate Ratios (MRR) From Specific Causes of Death Among Seamen in the Danish Merchant Marine 1970-85

Causes of death	Officer deck		Crew deck		Officer machine		Crew machine	
	MRR	N	MRR	N	MRR	N	MRR	N
Cancer respiratory organs	1.13 (0.81-1.57)	38	1.15 (0.81-1.60)	36	1.90 (1.39-2.60)	42	2.47 (1.59-3.82)	22
Cancer digestive organs	0.88 (0.58-1.34)	24	1.25 (0.88-1.78)	34	1.38 (0.90-2.08)	24	1.18 (0.55-2.44)	8
Ischemic heart disease	0.91 (0.74-1.13)	90	1.12 (0.92-1.36)	106	1.07 (0.84-1.36)	71	1.43 (1.02-2.00)	37
Cirrhosis of the liver	1.71 (0.99-2.90)	15	4.13 (2.99-5.68)	41	1.48 (0.75-2.82)	10	4.85 (2.55-8.98)	11
Suicide	1.02 (0.66-1.56)	23	1.87 (1.42-2.47)	53	0.98 (0.60-1.58)	18	1.31 (0.57-2.84)	7
Accidents	1.37 (0.93-2.00)	29	2.79 (2.25-3.46)	88	1.36 (0.91-2.03)	26	2.58 (1.43-4.55)	13

Adjusted for age.

N = number of deaths.

TABLE VIII. Mortality (MRR) From All Causes of Death Among Danish Seamen With Different Duties on Board, Age, and Marital Status

Marital status	Age (years)	Officers deck		Crew deck		Officers engine		Crew engine	
		MRR (95% CI)	N	MRR (95% CI)	N	MRR (95% CI)	N	MRR (95% CI)	N
Married	20-34	1.23 (0.64-2.36)	9	2.38 (1.35-4.11)	14	2.50 (1.51-4.16)	14	2.36 (0.41-9.53)	2
	35-49	0.82 (0.68-0.99)	109	1.14 (0.85-1.51)	51	1.77 (1.42-2.22)	75	1.25 (0.68-2.26)	12
	50-64	0.95 (0.82-1.09)	199	1.08 (0.92-1.27)	146	1.20 (1.02-1.42)	140	1.42 (1.08-1.87)	56
Unmarried	20-34	1.64 (0.88-3.03)	10	2.74 (2.24-3.34)	105	1.64 (1.11-2.42)	25	3.53 (1.72-6.98)	9
	35-49	1.48 (0.95-2.32)	19	1.68 (1.36-2.08)	92	1.36 (0.97-1.91)	34	0.78 (0.42-1.41)	23
	50-64	1.40 (0.83-2.38)	14	1.85 (1.47-2.34)	78	0.99 (0.75-1.29)	11	1.22 (0.93-1.61)	33

Controlled for follow-up periods.

CI, confidence interval; N = number of deaths.

cause of vague guidelines for the mortality registration (personal communication, National Board of Health, Denmark). Furthermore, it is likely that many of the certificates of death, signed by the captain as the medical authority on board, have been signed without information on cause of death because of lack of diagnostic skill. So, most of the deaths that occurred on board ships have probably been registered without information on cause, leading to an underestimation of mortality rate ratios,

primarily from diseases and circumstances which lead to sudden death, such as CVD, IHD, suicide, and accidents.

Arner and Tenfjord [1964] found what they called "negative" selection into the occupation, despite compulsory preemployment and periodical medical examination, probably due to a great need for seafarers. Arner and Tenfjord concluded that the high mortality caused by accidents, suicide, and cirrhosis of the liver, to some extent, could be explained by selection of persons with mental disorders, persons predisposed to alcoholic abuse, or persons with poor social adaptation, i.e., "negative" selection. This type of selection into the occupation could also have occurred in the present study population, accounting for a part of the excess mortality. There were 37% of seamen unmarried as compared with 20% unmarried in the reference population. This relatively high proportion of unmarried seamen may reflect "negative" selection into seafaring or could have been determined by the social conditions prevailing in the occupation. Still, MRR from all causes of death was significantly increased for both married and unmarried young seamen (Table VIII).

The results showing an excess mortality from cancer in the respiratory organs among engine officers and crew could be confounded by smoking, about which we have no information. But it is striking that we did not find a corresponding excess mortality among deck officers and crew, from whom we would expect almost the same smoking habits. In addition, we would expect an increased mortality from other diseases related to smoking, such as CVD and IHD. This was not the case for engine officers (Tables V and VII). In their study Rafnsson et al. [1988] could not explain the increased lung cancer mortality among marine engineers and machinist by excess smoking habits, and Baksaas et al. [1983] found excess mortality from lung cancer among all groups of seamen, even after adjustment for smoking. In other studies, findings of increased lung cancer among seamen have been explained by exposure to asbestos, oil mist, and exhaustion fumes in engine rooms [Selikoff et al., 1990; Velonakis et al., 1989; Varouchakis et al., 1991; Jones et al., 1984].

We failed to find an increased mortality from CVD among deck officers, as suggested from other studies, and this could be explained by the high number of deaths without information on causes. During the three 5-year periods there was a twofold increase in mortality rates from CVD among deck officers in the same age groups, and a fall of one third in the mortality rates among those without information on causes (Table II), so misclassification of deaths from CVD could have occurred, leading to an underestimation.

CONCLUSIONS

The study confirms previous findings of a mortality pattern showing increased overall mortality, highest among young seamen, crew members, and the unmarried, and a high mortality among engine officers and crew from cancer in the respiratory organs. Furthermore, we found an increased mortality from cirrhosis of the liver, especially among crew members, indicating excess alcohol consumption and perhaps excess morbidity from hepatitis. The negative health effects from excess alcohol consumption are well known, and as in other workplaces, there is a need for initiatives of preventing and reducing excess alcohol consumption on ships.

In the present study it was not possible to distinguish deaths caused by work-related accidents from deaths caused by other accidents. Therefore, further research

is needed to highlight the incidence, causation, and consequences of accidents on ships, with the aim of prevention through safety promotion programs. In Denmark there is a rapid turnover of ships in the merchant marine, and the average age of ships in 1988 was only 8.3 years [Industriministeriet, 1991]. The finding of excess mortality from cancer in the respiratory organs among engine officers and crew could be explained by exposure from carcinogens in the engine room. If so, the exposures have come from ships no longer in use in Denmark. Taking into account the improvement in ship technology, further risk assessment of lung cancer among engine officers and crew should be addressed to exposure measurements in the existing ships, to determine if there is any exposure to carcinogens, and to future surveillance of lung cancer among seamen.

REFERENCES

- Arner O, Tenfjord OW (1964): Sykdom, ulykker og død blant norske sjømenn. *Tidsskr Nor Lægeforen* 84:1228-1236.
- Baksaas I, Lund E, Skjerven JE, Langard S, Vellar OD, Aaro LE (1983): [Cancer in merchant seamen. A group study]. *Tidsskr Nor Lægeforen* 103:2317-2320.
- Danmarks Statistik (1972): Danmarks skibe og skibsfart 1970 (Danish ship and shipping 1970). *Statistiske Meddelelser (Copenhagen)* 1972:5.
- Hammar N, Alfredsson L, Smedberg M, Ahlbom A (1992): Difference in the incidence of myocardial infarction among occupational groups. *Scand J Work Environ Health* 18:178-185.
- Harrington JM (1972): Mortality from coronary artery disease of English Channel pilots and Hamburg pilots. *Trans Soc Occup Med* 22:19-22.
- Industriministeriet (1991): *Det blå Danmark*. Copenhagen: Industriministeriet.
- Jones RN, Diem JE, Ziskind MM, Rodriguez M, Weill H (1984): Radiographic evidence of asbestos effects in American marine engineers. *J Occup Med* 26:281-284.
- Kelman HR, Kavalier F (1990): Mortality patterns of American merchant seamen 1973-1978. *Am J Ind Med* 17:423-433.
- Larsson TJ, Lindquist C (1992): Traumatic fatalities among Swedish seafarers 1984-1988. *Saf Sci* 15:173-182.
- Moen B, Riise T, Helseth A (1990): Cancer among captains and mates on Norwegian tankers. *APMIS* 98:185-190.
- Morabia A, Markowitz S, Garibaldi K, Wynder EL (1992): Lung cancer and occupation: Results of a multicentre case-control study. *Br J Ind Med* 49:721-727.
- Nordisk Statistisk Sekretariat (1988): *Dødelighed og erhverv i Norden 1971-80*. Copenhagen: Nordisk Statistisk Sekretariat.
- Nyström L, Kolmodin-Hedman B, Jönsson E, Thomasson L (1990): Mortality from circulatory diseases, especially ischaemic heart disease in sea pilots and boatmen in Sweden 1951-84: A retrospective cohort study. *Br J Ind Med* 47:122-126.
- Otterland A (1960): "A Sociomedical Study of the Mortality in Merchant Seafarers." Gøteborg: Akademiforlaget, pp 1-300.
- Rafnsson V, Johannesdottir SG, Oddsson H, Benediktsson H, Tulinius H, Magnusson G (1988): Mortality and cancer incidence among marine engineers and machinists in Iceland. *Scand J Work Environ Health* 14:197-200.
- Rapiti E, Turi E, Forastiere F, Borgia P, Perucci CA, Axelson O (1992): A mortality cohort study of seamen in Italy. *Am J Ind Med* 21:863-872.
- Rothman KJ (1986): "Modern Epidemiology." Boston: Little, Brown and Company.
- Selikoff IJ, Lilis R, Levin G (1990): Asbestotic radiological abnormalities among United States merchant marine seamen. *Br J Ind Med* 47:292-297.
- Tuchsen F, Bach E (1992): *Erhverv og hospitalsindlæggelser 1981-84. Udvalgte diagnoser*. Copenhagen: Arbejdsmiljøfondet.
- Varouchakis G, Velonakis EG, Amfilochiou S, Trichopoulos D (1991): Asbestos in strange places: Two case reports of mesothelioma among merchant seamen. *Am J Ind Med* 19:673-676.

- Velonakis EG, Tsorva A, Tzonou A, Trichopoulos D (1989): Asbestos-related chest X-ray changes among Greek merchant marine seamen. *Am J Ind Med* 15:511-516.
- Vuksanovic P, Goethe WHG (1986): Mortality and lethality among seamen. *Bull Inst Mar Trop Med* 37:201-217.
- Vuksanovic P, Low A, Herrmann R (1991): Diseases and accidents among European seafarers. In "Proceedings from The International Symposium on Maritime Health." Turku, Finland, pp 187-201.
- Zorn EW, Harrington JM, Goethe WHG (1977): Ischemic heart disease and work stress in West German sea pilots. *J Occup Med* 19:762-765.