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Cardiovascular disease mortality in British merchant shipping and among British seafarers ashore in Britain

Stephen E Roberts[1], Bogdan Jaremin[2]

[1]School of Medicine, Swansea University, UK
[2]Institute of Maritime and Tropical Medicine, Medical University of Gdansk, Poland

ABSTRACT

Background. *The objective was to investigate trends in work-related mortality from cardiovascular disease (CVD) among seafarers employed in British merchant shipping from 1919 to 2005, to compare CVD mortality among British seafarers at work in British shipping — and ashore in Britain — with that in the general British population, and to investigate work-related CVD mortality in British shipping during recent years according to factors such as rank, nationality, location, and type of ship.*

Material and methods. *A longitudinal study based on examination of death inquiry files and death registers, official death returns, and information from occupational mortality decennial supplements. The main outcome measures were population-based mortality rates and standardised mortality ratios.*

Results. *There was an increase in work-related CVD mortality throughout much of the period from 1919 to 1962, but a subsequent reduction to 2005. Work-related mortality from CVD and ischaemic heart disease (IHD) was lower among seafarers employed in British shipping than in the corresponding general population (SMRs = 0.35 to 0.46), but mortality from CVD among British seafarers ashore in Britain was often increased. An elevated risk of work-related CVD mortality was also identified among the crews of North Sea offshore ships.*

Conclusions. *This study shows a healthy worker effect against CVD mortality among seafarers at work in British shipping, but increased risks among British seafarers ashore in Britain, which would include seafarers discharged through CVD morbidity and other illnesses. The high risks of CVD mortality among seafarers in North Sea supply ships may reflect particular work-related hazards in this sector.*

Key words: seafarers, cardiovascular disease, ischaemic heart disease, British merchant shipping

INTRODUCTION

Merchant seafaring has for long been associated with high rates of fatal injuries and drowning [1–4], suicide [2, 5–8] and homicide [2, 9]. Traditionally, seafarers have also been associated with high risks of mortality at work from infectious and gastrointestinal diseases [2, 10–13].

More recently, cardiovascular disease (CVD) has been the main cause of work-related mortality from disease at sea among seafarers in British shipping from 1976 to 1995 [14], and in other merchant fleets during the last 40 or 50 years, including those of Poland [3, 15], Denmark [16], Singapore [17], Sweden [18], and the Isle of Man [19].

Dr Stephen E Roberts, School of Medicine, Swansea University, Singleton Park, Swansea SA2 8PP.
Tel.: +44 (0) 1792 513433/513426, fax: +44 (0) 1792 513423, e-mail: stephen.e.roberts@swansea.ac.uk

In the general populations of European and other western countries there were typically increases in mortality from CVD over most of the twentieth century but quite sharp reductions in recent decades [20, 21]. Little is known, however, about long-term trends in mortality from CVD among seafarers. There is also interest as to whether crews of North Sea offshore vessels may be associated with increased risks of CVD mortality. However, little is known about how CVD mortality varies according to type of ship, nationality, and rank of crew.

The main objectives of this study were, firstly, to identify all work-related fatalities from CVD among seafarers who were employed on board British merchant ships between 1919 and 2005 and to establish long-term trends in work-related CVD mortality over the 87-year study period, secondly, to compare CVD mortality among British seafarers at work in British shipping — and ashore in Britain — with that in the general British population, and, thirdly, to investigate work-related CVD mortality in British shipping during recent years according to factors such as rank, nationality, location, and type of ship.

MATERIALS AND METHODS

Since 1874, deaths at sea in British merchant ships have been registered at the Registry for Shipping and Seamen (RSS), previously known as the Registrar General for Shipping and Seamen (RGSS), rather than with local registrars of deaths. Hence, work-related mortality among seafarers has not been administrated conventionally and has generally not been included in central mortality returns and publications, including census based occupational mortality decennial supplements.

INCLUSION CRITERIA

This study included all work-related fatalities from CVD among seafarers who were employed on board merchant ships of 100 gross tonnes and over, which were registered at a British port, during the period from 1st January 1919 to 31st December 2005. From 1976 to 2005 the study included deaths from CVD that occurred at work or within 30 days of any discharge ashore through illness. Before 1976, the study included deaths from CVD that occurred at work or following discharge ashore to a hospital in a foreign country, but usually excluded deaths that occurred after discharge to a hospital in the UK. Fatalities among non-crew members who were not signed on the ships' articles of agreement were excluded, as were fatalities in non-merchant ships.

INFORMATION SOURCES FOR WORK-RELATED CVD MORTALITY

In this study, details of the causes and circumstances of all work-related fatalities from CVD (ICD-9 codes = 390–429) among seafarers who were employed in British shipping from 1976 to 2005 were collected from documents held in death inquiry files and from death registers held at the RSS. These documents included official death returns, death certificates, autopsy reports, marine inquiries, and extracts from ships' log books. For the earlier period from 1919 to 1975, basic details of the work-related CVD fatalities were obtained from annual death returns that were based largely on the files at the RSS. These were published variously by the Board of Trade, the Ministry of Transport, the Department of Trade and Industry, the Department of Industry, and the Department of Trade, as described previously [8].

COMPARISON OF CVD MORTALITY WITH THE GENERAL POPULATION

To compare mortality among British seafarers with that in the corresponding general British population, standardised mortality ratios (SMRs) were used. SMRs for work-related deaths from CVD and ischaemic heart disease (IHD) among British seafarers employed in British shipping were calculated using the indirect method, applying the corresponding age- and sex-specific CVD and IHD mortality rates in the general British male working-aged population to the numbers of British seafarers in the British merchant fleet in the corresponding age groups. They were calculated for the periods 1958–1964 and 1968–1974, based on the last censuses of seamen [22], and mortality rates in the general population during 1961 and 1971, respectively [23]. Among British seafarers ashore in Britain, fatalities from various CVD and corresponding SMRs were identified through successive Registrar General's occupational mortality decennial supplements, based around the 1951, 1961, 1971, and 1981 censuses [24–27]. Similar information for SMRs at the time of the 2001 census was obtained through a commissioned request to the Office for National Statistics.

POPULATION AT RISK

The populations of seafarers annually employed in the British merchant fleet from 1919 to 2005 were obtained from annual government publications, produced variously by the Board of Trade, the Ministry of Transport, the Department of Trade and Industry, the Department of Trade, the Department of Trans-

port, the Marine Accident Investigation Branch, and the Maritime and Coastguard Agency, as described previously [8].

There was a reduction in the number of seafarers in British shipping, from 256,660 in 1919 to 34,000 in 2005, with a total population of 11.90 million seafarer-years over the 87 years. Seafarers who were signed on Asiatic agreements (Lascars) in British shipping were recorded separately from the other (mainly British) seafarers from 1924 to 1972; a total population of 2.19 million seafarer-years for Lascars, compared with 6.83 million for other seafarers. According to the last censuses of seamen of British ships in 1961 and in 1971, respectively, 86.0% and 92.4% of the seafarers who were not on Asiatic agreements on the census dates were British seafarers [22]. The main outcome measures were population-based mortality rates and SMRs. Linear regression was used to assess the significance of percentage annual changes in mortality rates.

RESULTS

From 1919 to 2005 there were 23 291 work-related fatalities from natural causes in British shipping. CVD was identified as the cause of 4601 (19.8%) of these deaths, although this is an underestimate as 2052 (8.8% of all deaths from natural causes) were classified as ill defined or from unknown causes. There was a slight increase in mortality from CVD during the 1920s and 1930s, a dip during the 1940s, an increase during the 1950s with a peak in 1962, and a continuing decline since then (Figure 1A). From 1919 to 1962, CVD mortality increased significantly ($p < 0.001$; average of 1.66% per annum). From 1963 to 2005 it fell by an average of 1.69% per annum ($p < 0.001$).

Over the course of the twentieth century, CVD has become increasingly the most important cause of work-related mortality from disease in British ships, increasing from < 15% in the 1920s to 45% in the 1950s and to > 80% since 1990 (Figure 1B). Mortality rates for CVD were similar among Lascar and non-Lascar seafarers from the 1920s to the 1940s, they were higher among Lascars during the 1950s and early 1960s, but converged during the late 1960s (Figure 2).

COMPARISON OF CVD MORTALITY WITH THE GENERAL POPULATION

For work-related fatalities among British seafarers employed in British shipping, SMRs for CVD were 0.36 (95% CI = 0.33–0.40) during 1958–1964 and 0.35 (0.31–0.40) during 1968-1974. Corresponding SMRs for IHD were 0.40 (0.36–0.44) and 0.46 (0.40–0.52), respectively.

Table 1 shows the numbers of fatalities and corresponding SMRs for various CVDs among British seafarers ashore in Britain at the time of the 1951, 1961, 1971, 1981, and 2001 censuses. SMRs were often increased (significantly or non-significantly) for most types of CVD specified in the decennial supplements — but not usually for chronic rheumatic heart disease — and were often higher among ratings than among officers.

WORK-RELATED CVD MORTALITY IN BRITISH SHIPS IN RECENT YEARS

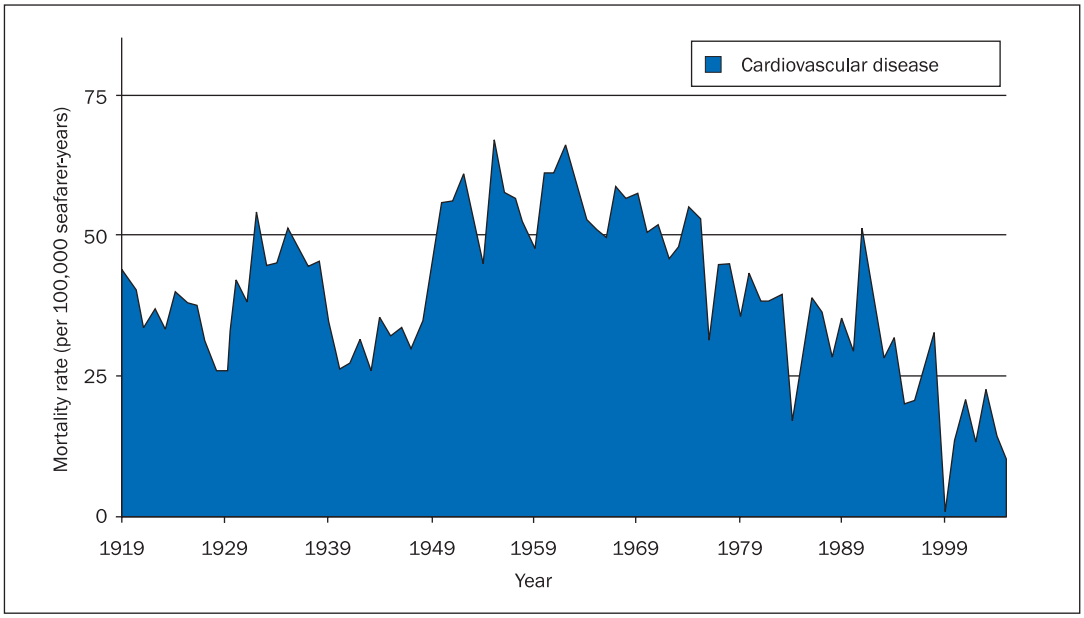
From 1996 to 2005 there were 49 work-related fatalities from CVD among seafarers in British merchant ships (Table 2). Of these, 44 were from IHD, four were from heart failure, and one was from pulmonary heart disease. All of the deceased were men, and the mean age at death was 51.0 years (SD = = 8.8; range = 28–61 years).

Most of the deceased (55%) were employed in coastal trading ships, including offshore vessels and passenger ferries (Table 2). This compares with 37% in coastal ships during the preceding 20 year period from 1976 to 1995 when most of the deceased were employed in deep sea trades (Table 2). Most of the deceased (86%) were British nationals, which compares with 74% during 1976–1995 when more Asian seafarers (20% of all fatalities) were employed.

Most fatalities (61%) occurred at sea rather than in port — most frequently in the North Sea and the English Channel — which also contrasts with 1976–1995, when most (58%) occurred in port or anchorage rather than at sea (Table 2). Forty-eight were taken ill on board ship. For the 32 whose precise location was known at the time, most (20) were in cabins and most (21) died in their cabins. Twenty-three were known to be off duty and 11 were on duty (not known = 15). Fifteen of 36 were known to have been found dead and only one (2%) was evacuated to hospital before death (Table 3).

Figure 3 shows crude mortality rates for work-related fatal CVD according to the type of ship (expressed per 1000 ship-years at risk) over the 30 year period from 1976 to 2005. Mortality from CVD was highest in the intensively manned passenger sector (28 per 1000 ship-years); it was high in deep sea trading ships such as bulk carriers (16) and container ships (17), intermediate in general cargo ships (10) and tankers (9), and lowest in small vessels

A. Cardiovascular disease



B. Cardiovascular disease and all diseases

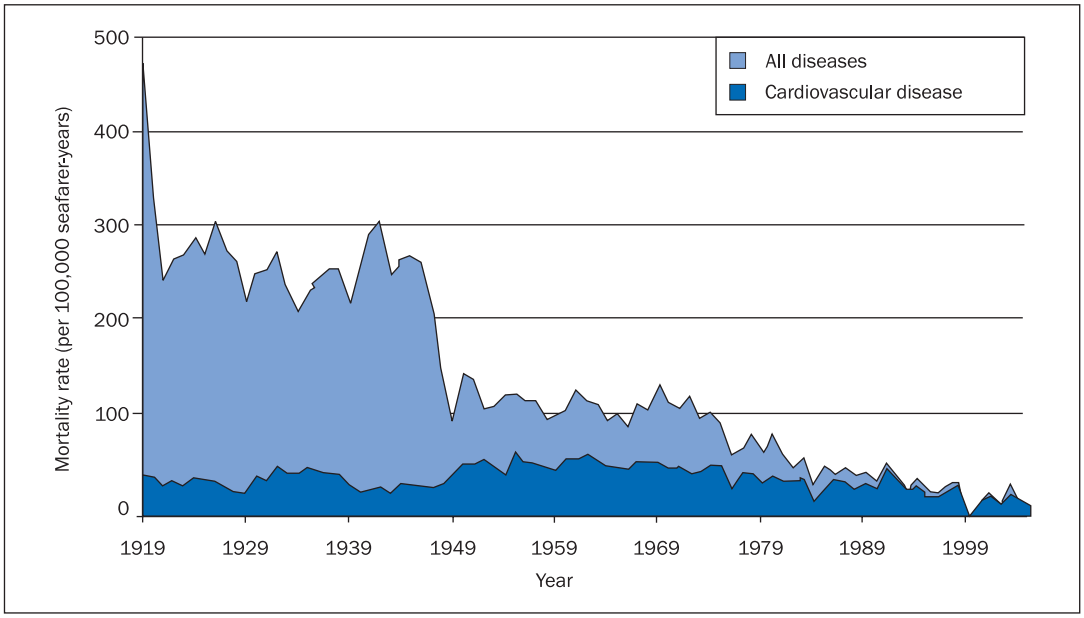


Figure 1. Trends in mortality rates among seafarers employed in British merchant shipping from 1919 to 2005 for work-related fatalities from

— tugs (0.7) and dredgers (8). However, CVD mortality was second highest — after passenger ships—in offshore vessels (19 per 1000) which are also small ships (mean gross tonnage = 1088). Of the 55 deaths among the crews of offshore ships, most (49; 89%) were located in the North Sea sector, and the ranks of the deceased were: captains (8), deck officers (5), engineering officers (18), deck ratings (17), engine room ratings (3), and other crew (4). The quinquennial numbers of CVD deaths in the offshore sector from 1976–1980 to 1981–1985 up to 2001–2005 were as follows: 11, 11, 11, 10, 5, and 7, respectively.

DISCUSSION

This study found an increase over time in mortality from work-related CVD in British merchant shipping from 1919 to the early 1960s, but a subsequent reduction since then. When compared with the gen-

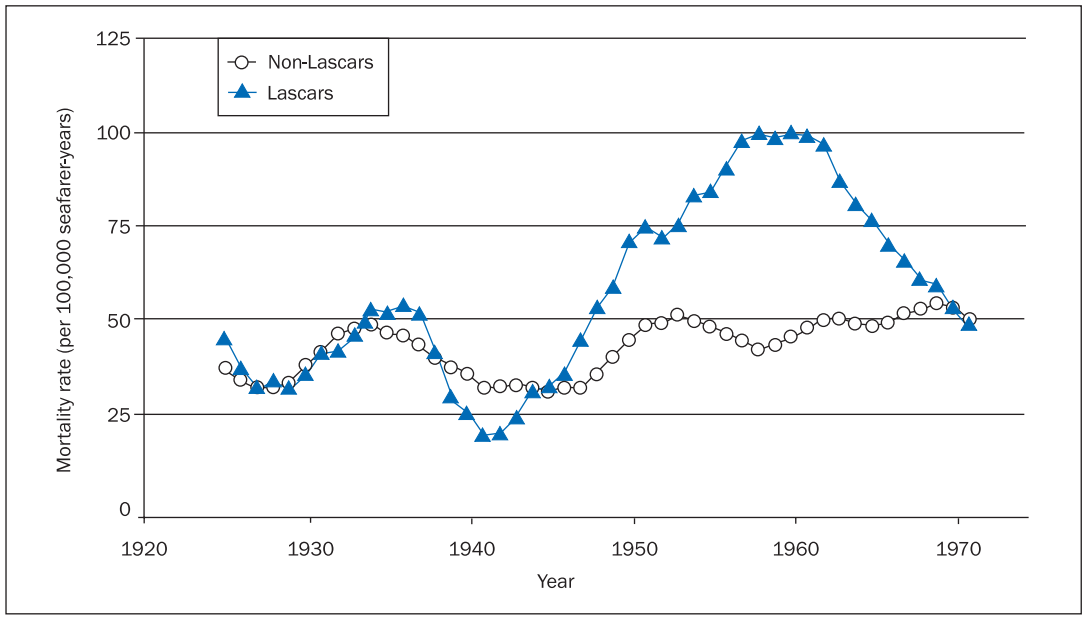


Figure 2. Trends in mortality rates for work-related fatalities from cardiovascular disease among Lascar and non-Lascar seafarers employed in British merchant shipping from 1924 to 1972

eral male working-aged British population, British seafarers had substantially lower work-related CVD and IHD mortality, but British seafarers ashore in Britain often had higher mortality from various CVDs. There was also evidence of high rates of work-related CVD mortality among crews in the North Sea offshore sector of British shipping.

Major strengths of this study include firstly its size. It covers more than 23 000 work-related fatalities from CVD for a defined population of 11.90 million seafarer-years over 87 years to study long-term trends. During the recent years, it is based on extensive examinations of paper death inquiry files to establish the causes and circumstances of the work-related fatalities, and it is based on information sources that are reliable in identifying both work-related mortality and non-work related mortality ashore in Britain.

Study limitations are, firstly, that there is uncertainty as to the reliability of cause of death ascertainment and certification for some of the deaths. Although these would have improved over time, some may be unreliable in earlier years when sea burials were quite common, particularly on long deep sea tours. Secondly, there have been minor changes in inclusion criteria over the 87-year study period; for example, as to the inclusion of deaths following discharge ashore in Britain. However, these changes would be insufficient to affect the long term trends in mortality substantially. Thirdly, the ages of the seafaring populations crewing the British fleet were not known for most years, so mortality rates could not be standardised when investigating trends in mortality over time, or when comparing mortality across groups of seafarers. Nonetheless, with a high recruitment of young seafarers and dropout of older seafarers, it is unlikely that the ages of the crewing populations would have changed much over time. For example, 63% and 59% of the crew were aged under 35 years, respectively, in the last two censuses of seamen in 1961 and 1971 [22]. When investigating mortality according to the type of ship, since disaggregated crewing population was not available, mortality rates were based on ship-years at risk, which is an inferior measure as crewing levels vary according ship type and have fallen over time with advances in technology. Nonetheless, this method was still useful in identifying high rates of fatal CVD among the crews of North Sea offshore ships. A further limitation is that the inquiry documentation is often less detailed for deaths from natural causes, so it is not possible to assess medico-legal implications of fatalities, and in recent years a higher proportion of fatalities have occurred on board smaller ships which often have less detailed log books to help establish the circumstances.

There was an increase in the work-related CVD mortality rate in British shipping during much of the period from 1919 to the early 1960s, which is similar to that in the general population of the UK and

Table 1. Numbers of deaths from various cardiovascular diseases with corresponding SMRs among British seafarers ashore in Britain

	Officers		Ratings		All seafarers	
Census year(s) and cardiovascular disease	**No. of deaths**	**SMR**	**No. of deaths**	**SMR**	**No. of deaths**	**SMR**
1951						
Coronary disease‡					545	1.63*
Chronic rheumatic heart disease					46	0.82
Chronic endocarditis†					40	2.35*
Other myocardial degeneration					113	1.64*
Hypertensive heart disease					105	1.75*
General arteriosclerosis					11	1.10
1961						
Coronary disease‡	259	1.52*	393	1.42*		
Chronic rheumatic heart disease	6	0.50	23	1.15		
Chronic endocarditis†	11	2.20	21	2.62		
Other myocardial degeneration	11	1.57	22	2.00		
Hypertensive heart disease	23	1.44	41	1.64		
General arteriosclerosis	3	1.50	4	1.33		
1970–1972						
Ischaemic heart disease	149	1.72*	261	1.67*		
Chronic rheumatic heart disease	4	1.00	13	1.82		
Hypertensive disease	9	2.22	26	3.58*		
Other forms of heart disease	5	0.98	22	2.44*		
1979, 1980, 1982, 1983						
Ischaemic heart disease	183	1.16*	314	1.85*		
Acute myocardial infarction	128	1.23*	233	1.81*		
Chronic rheumatic heart disease	1	0.63	2	0.83		
Hypertensive disease	1	0.42	15	3.57*		
Disease of pulmonary circulation	2	1.23	3	1.03		
Other forms of heart disease	19	2.85*	19	2.04*		
2001–2005						
Ischaemic heart disease	58	1.31	134	5.04*	192	2.71*

Notes
*Denotes significance at the 5% level
‡Includes angina
†Not specified as rheumatic

other European and western countries. These increases, which often occurred later in eastern Europe, largely affected men aged 40 to 60 years and were often linked to increases in classic risk factors such as obesity, smoking, sedentary work, and less active lifestyles. Subsequent reductions in CVD mortality in British shipping since the 1960s are also similar to those in many national populations, although in some countries the reductions began later in the 1970s, 1980s, or 1990s [21]. These reductions in general populations have also been linked to changes in risk factors, as well as improvements in diagnostics, pre- and post-hospital treatment, and management of acute and chronic circulatory diseases.

Table 2. Characteristics of fatalities from work-related cardiovascular disease among seafarers employed in British merchant shipping from 1996 to 2005 and, for comparison, from 1976 to 1995

	1996–2005		1976–1995	
Characteristic	**No. of fatalities (%)**		**No. of fatalities (%)**	
Sex				
Male	49	100.0	426	99.8
Female			1	0.2
Rank				
Captain	3	6.1	40	9.4
Deck officer	3	6.1	22	5.2
Engineering officer	11	22.4	53	12.4
Bosun	3	6.1	29	6.8
Deck rating	14	28.6	98	23.0
Engine room rating	3	6.1	60	14.1
Catering/Other	7	14.3	125	29.3
Nationality				
British	42	85.7	316	74.0
Other European	2	4.1	8	1.9
Asian		0.0	85	20.0
Other	5	10.2	18	4.2
Trade and type of ship				
Deep sea — Cruise	5	10.2	24	5.6
Deep sea — Tanker*	1	2.0	46	10.8
Deep sea — Bulk carrier			37	8.7
Deep sea — Container*	7	14.3	15	3.5
Deep sea — General cargo*			72	16.9
Deep sea — Liquefied gas carrier*			11	2.6
Deep sea — Royal Fleet Auxiliary	7	14.3	20	4.7
Deep sea — Other*	2	4.1	44	10.3
Coastal — Passenger ferry	9	18.4	35	8.2
Coastal — General cargo*			48	11.2
Coastal — Dredger	4	8.2	14	3.3
Coastal — Tug			5	1.2
Coastal — Offshore	12	24.5	44	10.3
Coastal — Other*	2	4.1	12	2.8
Location				
In port — UK	10	20.4	90	21.1
In port — France	2	4.1	11	2.6
In port — Europe — other	2	4.1	56	13.1
In port — Other	2	4.1	90	21.1
At sea — North Sea	13	26.5	54	12.6
At sea — English Channel	5	10.2	13	3.0
At sea — North Atlantic	3	6.1	35	8.2
At sea — South Atlantic	3	6.1	8	1.9
At sea — North Pacific	2	4.1	9	2.2
At sea — Other	4	8.2	61	14.3

Notes *Ships in coastal trades are defined as those under 2,000 gross tonnes, and those in deep sea trades as 2,000 gross tonnes or over

Table 3. Location of the ship and the deceased at the time of illness and at the time of death for work-related mortality from cardiovascular disease among seafarers employed in British merchant shipping from 1996 to 2005

	Location of the ship at time of Illness		Location of the ship at time of death	
Location of the deceased	**In port**	**At sea**	**In port**	**At sea**
On board the ship				
On the bridge		1		1
In the engine room		1		
On deck	3		3	
In a cabin	3	17	4	17
In a bathroom		1		1
In the mess room or bar	2		2	
In the ship's hospital				1
Other	1	2	1	2
Not specified	6	11	4	11
Ashore				
At the quayside	1		1	
In hospital ashore			1	
Total	16	33	16	33

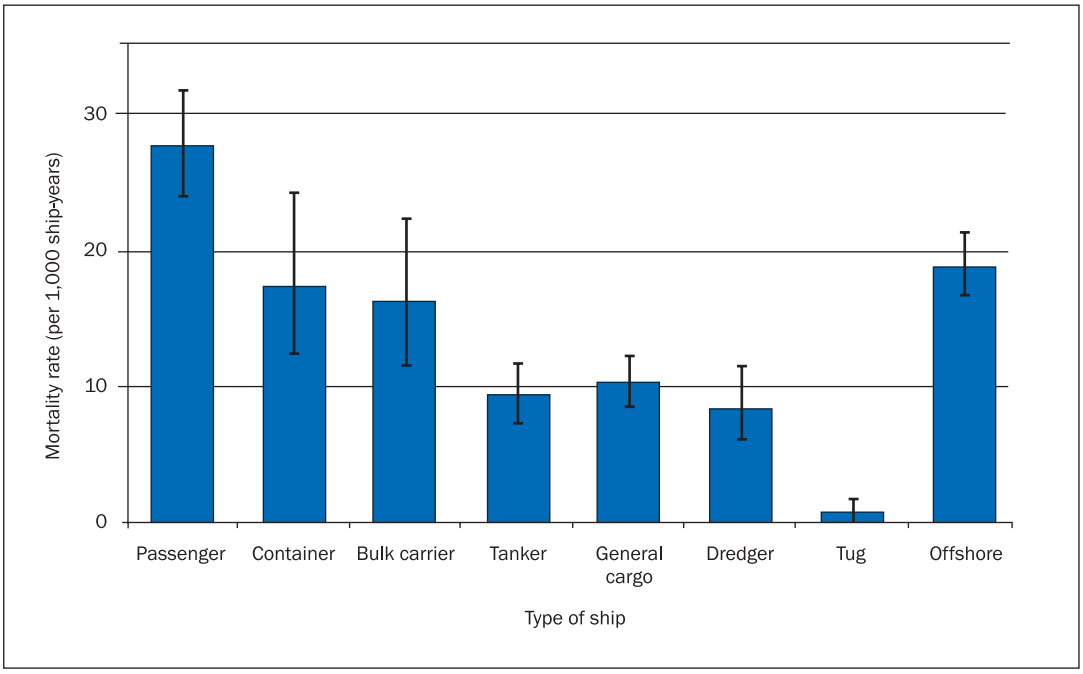


Figure 3. Mortality rates (per 1,000 ship-years) for work-related cardiovascular disease according to the type of ship in which the deceased was employed in British merchant shipping from 1976 to 2005

Several of these would also apply to seafarers, who had previously been linked with high prevalence of major risk factors for CVD [28–30]. At sea, however, logistical factors hinder many of the improvements in the treatment of CVD, so that the reductions in work-related CVD mortality among seafarers have

been more closely linked to reductions in the incidence of acute CVD, in particular through developments in medical examination procedures [31].

Although mortality from work-related CVD in British shipping has fallen sharply since the early 1960s, CVD has increasingly become the major cause of mortality from disease in British shipping (from < 15% in the 1920s to > 80% since 1990). However, this is because of major reductions over time in mortality from most other diseases, including infectious and respiratory diseases and many gastrointestinal disorders.

From the 1950s to the 1980s, work-related mortality from CVD and IHD was reduced among British seafarers who were employed in British shipping. However, British seafarers ashore in Britain often had increased mortality from various CVDs — including IHD — although usually not from chronic rheumatic heart disease. The reduced mortality at sea can be attributed mainly to the 'healthy worker effect' whereby seafarers who have diagnosed CVD and other major morbidities are usually prohibited from seafaring. The increased mortality ashore in Britain is at least in part because many of these seafarers would have been discharged ashore from active service because of sickness or disability, including CVD morbidity, and were therefore a much higher risk group than those at sea. Similarly, a previous cohort of non-work-related mortality ashore among seafarers in Denmark had an increased risk of mortality from natural causes [32], while two cohorts of Polish and Danish seafarers had no increased risk of work-related mortality from, respectively, acute MI and natural causes [31, 32]. If the work-related fatalities among seafarers at sea are combined with the fatalities ashore, the net mortality would be closer to that in the general population, which appears consistent with previous cohorts of Swedish, Danish, and Icelandic seafarers (covering both work-related mortality and mortality ashore) that had little or no overall increased risk of IHD [33–35].

Both work-related CVD mortality and CVD mortality ashore was often higher among ratings than among officers, which may reflect differences in lifestyle risk factors, education, and management of stress. During the 1950s and the early 1960s there were also higher rates of CVD among Lascars than among British seafarers, although rates were more similar at other times.

CVD mortality (based on ship-years at risk) was highest for large ships with the most crewmembers and lowest for small ships such as tugs and dredgers. It was, however, remarkably high in offshore vessels, which are also mainly small with few crewmembers. Almost all CVD mortality in offshore ships occurred in the North Sea, which would support concerns of increased CVD mortality among crews and captains in particular in this sector. It is possible that seafarers were older in this sector, although this is not known. However, time pressure to deliver supplies to offshore installations in frequently hazardous weather and sea conditions are thought to cause high stress levels for the captains and crews.

CONCLUSIONS

1. Work-related mortality from CVD among seafarers in British merchant shipping increased throughout much of the period from 1919 to 1962 but has continued to fall since that time.
2. Compared with the male working-aged British population, British seafarers typically had reduced mortality from CVD and IHD at work, which is linked to a healthy worker effect.
3. There was often increased CVD mortality among British seafarers ashore in Britain, which would include seafarers discharged through sickness.
4. High rates of CVD mortality among seafarers in the North Sea offshore sector should be subject to further research.

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