

Fatal accidents and injuries among merchant seafarers worldwide

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Background	The British merchant fleet has expanded in recent years but it is not known whether this expansion has led to proportionate changes in mortality.
Aims	To investigate mortality from accidents and injuries in British merchant shipping, to determine whether this has increased in recent years, to compare fatal accident rates across British industries and to review fatal accident rates in merchant shipping worldwide over the last 70 years.
Methods	Examinations of marine accident investigation files, death registers and death inquiry files, national mortality statistics, worldwide surveys and review methodology. The main outcome measure was the fatal accident rate per 100 000 worker-years.
Results	Of 66 deaths in British shipping from 2003 to 2012, 49 were caused by accidents, which largely affected deck ratings. The fatal accident rate in British shipping increased by 4.7% per annum from 2003, although this was not significant (95% confidence interval: -5.1 to 15.6%). During 2003–12, the fatal accident rate in shipping (14.5 per 100 000) was 21 times that in the general British workforce, 4.7 times that in the construction industry and 13 times that in manufacturing. Of 20 merchant fleets worldwide with population-based fatal accident rates, most have shown large reductions over time.
Conclusions	The expansion of the British merchant fleet in recent years does not appear to have had a major impact on fatal accidents. Further preventive measures should target fatalities during mooring and towing operations. Internationally, most shipping fleets have over time experienced large decreases in fatal accident rates.
Key words	Fatal accidents and injuries; merchant shipping; seafarers.

Introduction

Merchant seafaring has long been one of the most hazardous occupations [1–4]. It has also been associated with high risks of mortality from suicide, homicide, unexplained disappearances at sea and undetermined causes [1–4]. Throughout almost all of the 20th century, there was a sharp reduction in the fatal accident rate among seafarers employed in British shipping [4]. This was linked to several factors, including improvements in ship design, safety equipment and rescue services, a reduction in hazardous working practices and an increase over time in passenger shipping with a reduction in (higher risk) cargo shipping [4].

Following a ‘tonnage tax’ incentive introduced in 1999 [5] to encourage shipping companies to register their

ships in the British merchant fleet, the fleet expanded by >30% from 949 ships in 1999 to 1240 by 2011 [6]. The increase was greatest for cargo shipping (including tankers, bulk carriers, container and general cargo ships), which more than doubled in number from 1999 to 2011. It is unclear whether this expansion in the (cargo) fleet has led to any change in the fatal accident rate in recent years. Little is also known about trends in fatal accident rates in merchant fleets worldwide, and how they may have changed in recent years. The first aim of this study was to establish the causes and rates of mortality from accidents and injuries among seafarers employed in British merchant shipping during the 10-year period from 2003 to 2012 and to establish whether mortality rates have changed in recent years. Further aims were

to compare fatal accident rates across British industries and to review fatal accident rates across merchant fleets worldwide over the last 70 years.

Methods

Details of all deaths from external causes in British merchant shipping were identified from accident investigation data files provided by the Marine Accident Investigation Branch (MAIB). The MAIB is the authority that investigates all deaths from accidents in British shipping and is also notified of deaths from other external causes such as suicide, homicide, drowning and disappearances at sea found to be of undetermined intent. Additional details of fatalities were obtained from death registers and paper death inquiry files held at the Registry of Shipping and Seamen (RSS). Deaths at sea among seafarers employed in British ships are normally registered at the RSS rather than with local registrars of deaths. Ethical approval was not required as the study was based on death inquiry files. Study approval was obtained instead from the MAIB, RSS, Maritime and Coastguard Agency and coroners. Fatal accidents among seafarers were classified into three categories: firstly, 'maritime disasters', i.e. accidents or incidents involving ships, such as a collision, foundering or explosion; secondly, 'occupational accidents', i.e. personal accidents involving seafarers on duty and thirdly, 'off-duty accidents', i.e. personal accidents involving seafarers when off duty.

We included all traumatic work-related deaths among seafarers who were 'signed on' the articles of agreement and working on board British merchant ships of 100 or more gross tonnage between 1 January 2003 and 31 December 2012, provided that the deaths arose at work or within 30 days of any discharge ashore to hospital. The study excluded deaths among non-crew members, such as passengers and pilots, and deaths involving non-merchant ships, including yachts and fishing boats. The populations of seafarers employed in British merchant ships from 2003 to 2012 were based on surveys of seafarers conducted by the Maritime and Coastguard Agency [7]. Conventionally [1–4] the seafarers were counted as if they had been working at sea for the whole of each year, in order to enable direct comparison of fatal accident rates with workers in other industries. The total cohort under study thus comprises 338 203 seafarer-years. To compare fatal accident rates according to the type of ship, the numbers and types of British-registered merchant ships of 100 or more gross tonnage were obtained from annual Lloyd's Register of Shipping returns [6]. The fatal accident rate in British shipping from 2003 to 2012 was compared with that in the general British workforce and in the five main industrial sectors of Great Britain, using fatal accident information published annually by the Health and Safety Executive [8]. These fatal accidents included all that occurred in the workplace, excluding non-work-related traffic accidents and

self-inflicted poisoning by alcohol or drugs. To compare mortality in shipping worldwide, review methodology was employed to identify fleets with population-based fatal accident rates. The information sources used include two previous worldwide surveys of mortality in merchant fleets that were conducted by the authors in 1996 [9] and 2006 [10]: PubMed, OSH-ROM, CINAHL, SCOPUS, ScienceDirect, ASSIA and Ovid, with search terms including 'seafarers', 'seamen', 'accident', 'injury', 'mortality', '100 000', '10 000'; hand-searching of reference lists; and correspondence with leading investigators in maritime medicine and health worldwide. The study period for inclusion in this review was from 1945 to 2012. Fatal accident rates were expressed where possible in time periods of 10 years.

The main study outcome measures were mortality rates expressed per 100 000 worker-years or per 1000 ship-years. When studying antecedents to the fatal accidents from the marine accident investigation files, human or human-related factors, which can be defined as the human element in the safe and efficient operation of the ship, were distinguished from, firstly, mechanical or technical factors and, secondly, from environmental and weather-related factors. This is consistent with the classification used by the MAIB. Other methods of analysis include relative risks to compare fatal accident rates in shipping with other industries and logistic regression odds ratios with confidence intervals (CIs) to assess trends over time in fatal accident rates. CIs for fatal accident rates were adjusted for multiple fatalities that arose through the same accident, for example when a ship founders, by using a normal approximation to the compound Poisson distribution. Significance was defined at the 5% level.

Results

A total of 66 fatalities satisfied the inclusion criteria and were included in the study; of these, 49 were caused by accidents and 5 by suicides, while 12 deaths were of undetermined intent (4 drowning, 7 disappearances at sea and 1 drug intoxication; Table 1). The mean age of the deceased was 40 years (SD 13; range: 19–65). The nationalities of the deceased were British (31; 47%), other European (17), Asian (16), other and unknown (1 each). All but one (98%) were male. The causes of death were injuries (29), drowning (17), presumed drowning where missing (10), asphyxiation by fumes or by oxygen deficiency in enclosed spaces (5) and various other causes (5). Most deaths (38; 58%) occurred at sea with 28 in port. Three fatalities were caused by a maritime disaster, when a tug capsized after being struck by a bulk carrier in dense fog on the River Clyde. Forty-six fatalities were caused by personal accidents, including 37 when the seafarer was on duty and 9 when off duty. The most common type of fatal accident on duty was being

struck by mooring or towing ropes (7) or by various other objects (10), followed by falls on board (5), falls overboard (4) and asphyxiation in enclosed spaces (3) (Table 2). The 10 various other objects that fatally struck seafarers included passenger lifts and drilling equipment (2 each), a watertight door, a portable bulkhead, a dredging tower, a bell cursor, a derrick and a hatch cover. The nine fatal off-duty accidents refer to swimming accidents

Table 1. Causes of all work-related deaths from external causes among seafarers in British merchant shipping, 2003–12

Cause of death	Number of deaths (%)	Mortality rate per 100 000 seafarer-years (95% CI)
Accidents		
Maritime disasters	3 (5)	0.9 (0.0–2.6)
Occupational accidents	37 (56)	10.9 (7.1–14.8)
Off-duty accidents	9 (14)	2.7 (0.7–4.6)
Suicide	5 (8)	1.5 (0.5–3.4)
Undetermined intent		
Alcohol and drug intoxication	1 (2)	0.3 (0.0–1.6)
Drowned	4 (6)	1.2 (0.3–3.0)
Missing at sea	7 (11)	2.1 (0.8–4.2)
All accidents	49 (74)	14.5 (10.0–19.1)
All fatalities from external causes	66 (100)	19.5 (14.3–24.8)

(four), falls into docks when returning to ships from ashore (three) and falls on board (two). Seven of the nine fatalities were reported as alcohol related. Almost half of the fatal accidents (24; 49%) involved deck ratings (Table 2). The most frequently reported main causes of the fatal accidents were unsafe working practices (13), mechanical failure/deficiencies (12), negligence/perception of risk of the deceased (7), alcohol consumption (7), institutional complacency towards safety (6), inadequate training (4) and weather (2). Human factors (37 cases) predominated over mechanical factors (12) in most of the fatalities. Seafarers who died from accidents caused mainly by mechanical factors were of similar ages to those who died from accidents due to human factors (46 versus 43 years; not significant). Of the five confirmed suicides, three were by hanging and two jumped overboard. Of 12 deaths of undetermined intent, 1 died from heroin intoxication, 7 disappeared at sea and 4 were found drowned in docks or rivers. Although several of these were considered likely suicides in some death inquiries, there was speculation of homicide in some cases.

The fatal accident rate in British shipping increased by 4.7% per annum from 2003 to 2012 (Figure 1), although this was not statistically significant (95% CI: –5.1 to 15.6%). Similarly, the increase in the fatal accident rate since the introduction of the tonnage tax incentive in 1999 was also not statistically significant (mean annual increase = 3.8%; 95% CI: –2.7 to 10.1%). Of all

Table 2. Causes of all work-related deaths from external causes according to the rank of the deceased in British merchant shipping, 2003–12

Cause of death	Rank of the deceased							
	Captain	Deck officer	Engineer officer	Cadet	Deck rating	Engine room rating	Catering, steward and other	Total
Accidents								
Maritime disasters								
Foundered/capsized	1		1		1			3
Occupational accidents								
Asphyxiated in enclosed spaces					3			3
Falls overboard		1			3			4
Falls on board		1				2	2	5
Struck by mooring and towing ropes		1			6			7
Struck by other objects			2	1	4		3	10
Other occupational accidents			2		4	2		8
Off-duty accidents								
Falls into docks – returning to ship	1				1		1	3
Falls on board		1		1				2
Swimming accidents					2		2	4
Suicides		1	1		1		2	5
Undetermined intent								
Alcohol and drug intoxication							1	1
Drowned			1		1		2	4
Missing at sea			1	2	2	1	1	7
Total	2	5	8	4	28	5	14	66

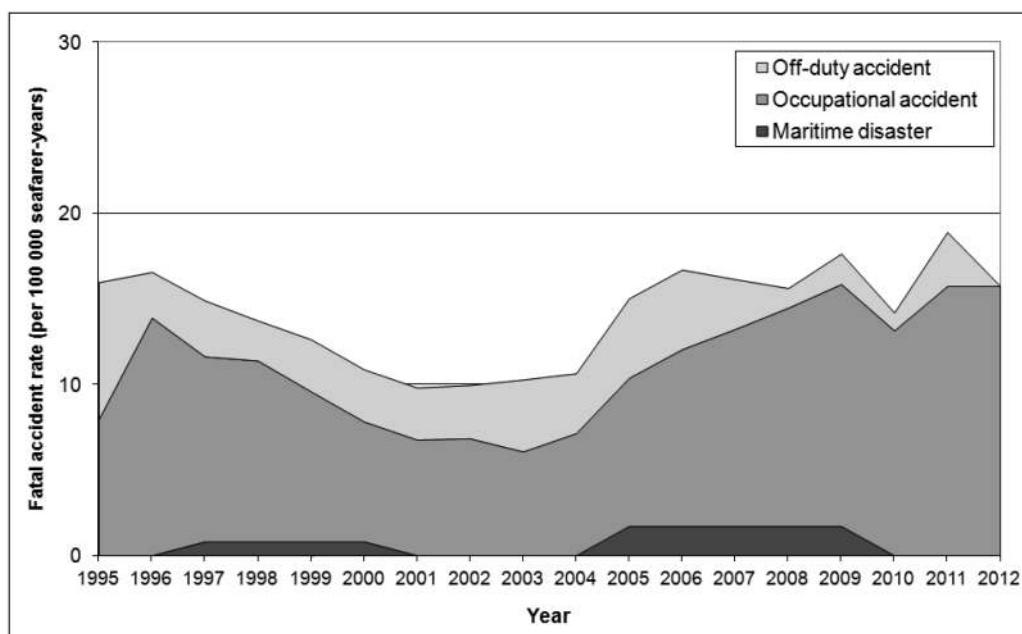


Figure 1. Trend in the fatal accident rate among seafarers employed in British shipping, 1995–2012. The fatal accident rate is smoothed using 5-year moving averages.

major types of ship, the highest fatal accident rates from 2003 to 2012 in terms of ship-years at risk were for the crews of container ships (8.0 per 1000 ship-years at risk) followed by bulk carriers (6.0 per 1000), offshore vessels (4.6), tugs and passenger ships (3.2 each), general cargo ships (2.9) and tankers (1.6). Taking account of average ship crewing levels, which are usually >3 times higher for larger container ships and bulk carriers compared with much smaller offshore vessels and tugs, the crews of offshore vessels and tugs have the highest fatal accident rates. The fatal accident rate in British merchant shipping (14.5 per 100 000) was 21 times that in the general British workforce (0.7 per 100 000) during the same period. It was also much higher than in all major shore-based British industries, 70% higher than in agriculture, forestry and fishing, 3.5 times that in the energy and utility supply industries, 4.7 times that in construction, 13 times that in manufacturing and 50 times that in service industries.

This review established 20 merchant fleets worldwide with population-based fatal accident rates since 1945 (Table 3). The highest fatality rates of >120 per 100 000 seafarer-years refer mainly to earlier decades up to the 1960s (Sweden, Norway, Germany and UK shipping) or Asian fleets in later decades (Singapore and Hong Kong). Of eight merchant fleets for which it was possible to identify long-term trends in fatal accident rates, there were mainly large reductions over time (Figure 2). However, there were increases or levelling off of fatal accident rates at times for some fleets, in particular for the UK fleet from the 1950s to the 1970s, for the Polish fleet from the 1970s to the 1980s and Danish shipping from the 1980s to the 1990s.

Discussion

This study found that the fatal accident rate in British merchant shipping from 2003 to 2012 was 21 times that in the general British workforce. Although the fatal accident rate increased by 4.7% per annum from 2003 to 2012, this was not statistically significant, which suggests that the recent expansion of the British fleet has had no major impact on fatal accidents.

Major strengths of the study are that it is based on extensive examinations of accident investigation and death inquiry files to establish the causes and circumstances of fatalities, and on reliable information sources to identify work-related mortality among a defined occupational population employed in British merchant shipping [4]. It is also based on review methodology to compare fatal accident rates in merchant shipping worldwide.

Limitations of the study include, firstly, that the review comparison of fatal accident rates across merchant fleets worldwide can be affected by variation in inclusion and exclusion criteria across studies, for example as to whether drownings of undetermined intent were included as accidents. However, these discrepancies are usually small, particularly as many of the studies in the review were obtained from worldwide surveys that specified the inclusion and exclusion criteria to be adopted [9,10]. Secondly, when investigating fatal accident rates according to the type of ship, they were based on ship-years, which is an inferior measure to person-years as crewing levels vary according to the type of ship and have fallen over time.

A previous study of long-term trends in the fatal accident rate in British shipping found a sharp reduction

Table 3. Fatal accident rates among seafarers employed in merchant fleets worldwide, 1945–2012: studies ordered by fatal accident rate

Merchant fleet	Time period	No. of deaths from accidents	Fatal accident rate per 100 000 seafarer-years (95% CI)	Study reference
Sweden	1945–54	847	370 (346, 396)	[1]
Norway ^a	1957–64	1027	276 (259, 293)	[11]
Germany	1954–63	827	199 (186, 213)	[12]
Singapore	1986–95	253	180 (159, 204)	[2]
Greece	1990–94	339	162 (145, 180)	[9]
Hong Kong	1986–95	82	159 (126, 197)	[13]
UK	1945–54	2280	140 (134, 146)	[4]
Germany	1964–72	485	126 (113, 138)	[12]
Iceland ^c	1966–76	67	108 (84, 137)	[14]
Norway ^b	1990–94	156	102 (87, 119)	[9]
Poland	1985–94	49	100 (74, 132)	[15]
Germany	1974–76	^d	92	[16]
Poland	1996–2005	52	84 (63, 110)	[10]
UK	1955–64	1571	80 (76, 84)	[4]
UK	1965–74	854	77 (72, 82)	[4]
Iceland ^c	1977–86	65	76 (59, 97)	[14]
UK	1975–82	512	75 (68, 81)	[4]
Denmark	1986–93	74	67 (53, 82)	[17,18]
Belgium	1990–94	3	63 (13, 184)	[9]
Japan ^b	1990–94	121	58 (48, 69)	[9]
Hong Kong	2000–05	44	56 (41, 75)	[10]
Denmark	1994–2001	64	55 (42, 70)	[18]
Iceland ^c	2001–05	14	54 (30, 91)	[19]
Poland	1960–69	48	51 (38, 68)	[20]
Isle of Man	2000–05	17	45 (26, 72)	[21]
Isle of Man	1988–99	16	43 (25, 70)	[21]
UK	1983–92	135	41 (17, 49)	[4]
The Netherlands	1990–94	15	39 (22, 64)	[9]
Germany	1990–94	35	39 (27, 54)	[9]
Poland	1970–79	57	39 (30, 51)	[20]
Sweden	1984–88	27	37 (24, 54)	[22]
Finland	1982–86	15	37 (21, 61)	[23]
Poland	2003–11	6	33 (12, 72)	Current study
Denmark	2002–09	31	27 (18, 38)	[18]
Canada	1996–2005	16	22 (13, 36)	[10]
France	1990–94	6	20 (7, 44)	[9]
Germany	2004–08	13	20 (10, 34)	[24]
India	1996–2005	26	18 (12, 26)	[10]
UK	2003–12	53	16 (11, 20)	Current study
Spain	1990–94	7	16 (6, 33)	[9]
UK	1993–2002	41	16 (10, 21)	[4]
Sweden	1996–2005	19	13 (8, 20)	[10]
Australia	1990–94	3	10 (2, 29)	[9]
Sweden	1990–94	9	10 (5, 19)	[9]

For improved comparability across studies, deaths from drowning of undetermined intent are included as accidental deaths.

^aIncludes deaths from suicide and homicide as well as accidents.

^bIncludes deaths from maritime disasters but not deaths from personal accidents.

^cIncludes deep sea fishermen as well as merchant seafarers.

^dNot available.

throughout most of the period from 1919 to 2005 [4]. This study provides a detailed analysis of all fatal accidents in British shipping during the 10-year period from 2003 to 2012 and investigates whether there has been any recent increase in fatal accidents. Although there has been a slight increase in the rate of fatal accidents, it was not

statistically significant, suggesting that random variability across years, rather than systematic safety problems, may be responsible for the rates we describe. Nonetheless, many British-owned cargo ships are still re-registered with ‘flags of convenience’: almost 40% were registered with foreign flags in 2011 [25]. It is therefore plausible that the

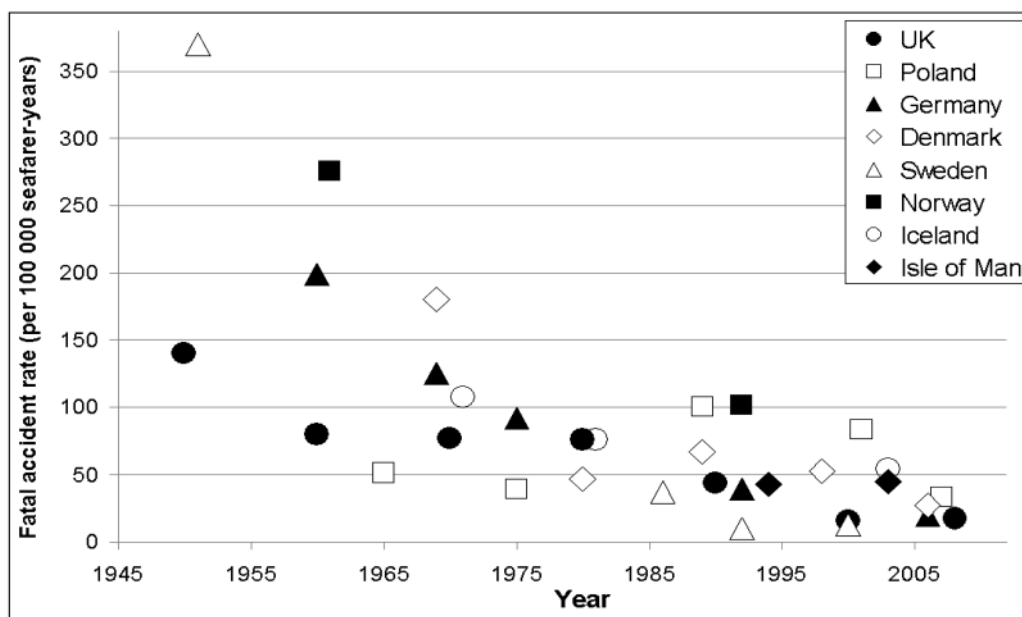


Figure 2. Trends in fatal accident rates among seafarers employed in merchant fleets worldwide, 1945–2012. References for these fatal accident rates are provided in [Table 3](#).

British fleet has expanded with safer ships that pass the UK's more stringent criteria for registration, while more hazardous cargo ships remain with open registers such as Belize, Panama and St Vincent and contribute to higher casualty and crew fatality rates in these flags [6,26].

Almost half of the fatal occupational accidents affected deck ratings, which is consistent with other studies internationally that have identified the deck department as carrying the highest risk of on-duty fatal accidents [2,13,17,21,27]. Non-fatal injuries and off-duty accidents are more evenly distributed across the three main departments (deck, engine and catering) [23,27,28], which suggests that the deck department has the largest exposure to the highest risk work duties. These include cargo-related operations on deck in bad weather, entering enclosed spaces such as cargo tanks and holds and mooring or towing operations. Mooring and towing operations are associated consistently with fatal injuries among seafarers internationally [1,2,13,17,27], particularly when ropes break under stress. Despite a sharp reduction over the last 40 years in the fatal accident rate in British shipping, seafarers being struck by mooring or towing ropes is one type of fatal accident that has increased over time. Prevention is typically aimed at inspection, maintenance and replacement of worn ropes and caution towards standing in proximity to ropes under stress. Although seafarers are generally aware of this, they were the main causes of three preventable fatalities during towing operations. Mooring operations allow less opportunity to avoid the hazards of standing near ropes. Hazards often arise when the ropes become tense due to sudden unforeseen ship movements, which was a contributory factor in two fatalities.

Drowning after falls overboard and asphyxiation in enclosed spaces (particularly cargo holds and tanks) have also been reported consistently among seafarers and are usually preventable [1,2,13,17,21,27]. Entry into tanks and holds for cleaning, routine inspection or maintenance/repair work can expose crew to oxygen-depleted, toxic or flammable atmospheres. Prevention should be aimed at adherence to recommended procedures and checklists when entering enclosed spaces, which have been extended progressively over time in shipping [29]. Fatalities through falls overboard can often be prevented by the use of self-inflating life vests or safety harnesses when engaged in potentially hazardous operations at great heights or along the sides of ships.

Human factors rather than mechanical factors were the cause of most fatal accidents. As major antecedents to the fatalities included unsafe working practices, negligence, flawed perception of risk and inadequate training, important preventive measures should include training and combining new crew members with more experienced seafarers. The goals of important procedures should be defined and explained before starting, with substantial risks identified and managed appropriately. Maintenance of sensors and controls is also important for prevention. These include oxygen and hazardous atmosphere sensors for entry into enclosed spaces and, for navigation, electronic chart display information systems in combination with global positioning systems, and bridge navigational watch alarms.

The fatal accident rate in British shipping from 2003 to 2012 is 21 times that in the general British workforce during the same time period, which is higher than

comparative UK relative risks of 16 from 1996 to 2002 [27] and 11 for Danish shipping from 1986 to 1993 [17]. This reflects the slight increase in the fatal accident rate in British shipping in recent years as well as a continuing reduction in the fatal accident rate in the general British workforce [8], which is one of the lowest in Europe [30]. Internationally, there have been mostly large reductions in fatal accident rates in merchant shipping over the last 70 years.

This study shows that the expansion of British shipping in recent years has had no major impact on fatal accidents. Further prevention efforts should particularly be aimed at fatalities during mooring and towing operations and when entering enclosed spaces.

Key points

- During 2003–12, the fatal accident rate in British merchant shipping (14.5 per 100 000) was 21 times that in the general British workforce, 4.7 times that in the construction industry and 13 times that in manufacturing.
- Human factors predominated over mechanical factors as the main causes of the fatal accidents.
- Of 20 merchant fleets worldwide with population-based fatal accident rates, there have been mostly large reductions in mortality over the last 70 years.

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Conflicts of interest

None declared.

References

1. Otterland A. *A Sociomedical Study of the Mortality in Merchant Seafarers*. Göteborg, Sweden: Scandinavian University Books, 1960.
2. Nielsen D, Panayides PM. Causes of casualties and the regulation of the occupational health and safety in the shipping industry. *WMU J Marit Affairs* 2005;4:147–167.
3. Jaremin B. Work-site casualties and environmental risk assessment on Polish vessels in the years 1960–1999. *Int Marit Health* 2005;56:17–27.
4. Roberts SE. Fatal work-related accidents in UK merchant shipping from 1919 to 2005. *Occup Med (Lond)* 2008;58:129–137.
5. House of Commons Transport Committee. *Tonnage Tax: Second Report of Session 2004–05. Report, Together With Formal Minutes, Oral and Written Evidence*. London, UK: The Stationery Office Ltd, 2005.
6. IHS Fairplay. *World Fleet Statistics, 1999–2011 [Annual Returns]*. London, UK: IHS Fairplay, 2000–2012.
7. Maritime and Coastguard Agency. *Crewing Estimates Based on Maritime and Coastguard Agency Surveys [data provided on request by the Maritime and Coastguard Agency]*. Southampton, UK: Maritime and Coastguard Agency, 2012.
8. Health and Safety Executive. *Health and Safety Statistics [Annual Reports for 2003–2012]*. London, UK: HMSO, 2004–2013.
9. Nielsen D, Roberts S. Fatalities among the world's merchant seafarers (1990–1994). *Marine Pol* 1999;23:71–80.
10. Roberts SE, Williams JC. *Update of Mortality for Workers in the UK Merchant Shipping and Fishing Sectors*. Southampton, UK: Maritime and Coastguard Agency, 2007.
11. Arner O. The role of alcohol in fatal accidents among seamen. *Br J Addict Alcohol Other Drugs* 1973;68:185–189.
12. Vuksanovic P, Goethe H. Diseases and accidents among seamen—an international comparison of distribution of diagnoses. *Bull Inst Marit Trop Med Gdynia* 1982;33:13–33.
13. Nielsen D. Deaths at sea—a study of fatalities on board Hong Kong-registered merchant ships (1986–95). *Safety Sci* 1999;32:121–141.
14. Rafnsson V, Gunnarsdóttir H. Fatal accidents among Icelandic seamen: 1966–86. *Br J Ind Med* 1992;49:694–699.
15. Jaremin B, Kotulak E, Starnawska M, Tomaszunas S. Causes and circumstances of deaths of Polish seafarers during sea voyages. *J Travel Med* 1996;3:91–95.
16. Vrcelj J. Todesfälle in der Seeschiffahrt. *Die Unfälle an Bord von deutschen Seeschiffen und ihre Ätiologie von 1974–76 [MD thesis]*. Hamburg, Germany: University of Hamburg, 1981.
17. Hansen HL. Surveillance of deaths on board Danish merchant ships, 1986–93: implications for prevention. *Occup Environ Med* 1996;53:269–275.
18. Borch DF, Hansen HL, Burr H, Jepsen JR. Surveillance of maritime deaths on board Danish merchant ships, 1986–2009. *Int Marit Health* 2012;63:7–16.
19. Sigvaldason K, Tryggvason FT, Petursdóttir G, Snorrason H, Baldursson H, Mogensen B. Fatal accidents and non-fatal injuries amongst seamen in Iceland 2001–2005. *Laeknabladid* 2010;96:29–35.
20. Jaremin B. Deceases of the Polish seamen and fishermen at maritime work-site in the years 1960–1999—analysis of phenomenon and impact of work environment, with particular reference to medical certification and possibilities of prevention. *Ann Acad Med Gedan* 2005;35 Suppl 1:1–212.
21. Roberts SE. Surveillance of work related mortality among seafarers employed on board Isle of Man registered merchant ships from 1986 to 2005. *Int Marit Health* 2006;57:9–23.
22. Larsson TJ, Lindquist C. Traumatic fatalities among Swedish seafarers, 1984–88. *Safety Sci* 1992;15:173–182.
23. Saarni H. Industrial accidents among Finnish seafarers. *Travel Med Int* 1989;7: 64–68.

24. See Berufsgenossenschaft Schiffssicherheit. *Annual Reports [2004–2008]*. Hamburg, Germany: See Berufsgenossenschaft Jahresbericht, 2005–2009.
25. Department for Transport. *Shipping Fleet Statistics 2011*. London, UK: Department for Transport, 2012.
26. IHS Fairplay. *World Casualty Statistics, 1999–2010 [Annual Returns]*. London, UK: IHS Fairplay, 2000–2011.
27. Roberts SE, Marlow PB. Traumatic work related mortality among seafarers employed in British merchant shipping, 1976–2002. *Occup Environ Med* 2005;**62**:172–180.
28. Tomaszunas S, Weclawik Z. Accidents and injuries in Polish seafarers. *Bull Inst Marit Trop Med Gdynia* 1997;**48**:59–73.
29. International Maritime Organisation. *ISM Code and Guidelines on Implementation of the ISM Code 2010*. London, UK: International Maritime Organisation, 2010.
30. Health and Safety Executive. *European Comparisons: Summary of GB Performance*. <http://www.hse.gov.uk/statistics/european/european-comparisons.pdf> (16 November 2013, date last accessed).

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