

# Non-cancer diseases requiring admission to hospital among German seafarers

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## ABSTRACT

**Background:** This study estimated the discharge diagnosis due to non-cancer diseases of German seamen employed on German vessels in comparison to the general German male population.

**Materials and methods:** In a database, the German health insurance company for seafarers determined the discharge diagnoses from hospital for all German seafarers. In the time period from January 1997 to December 2007, this database encompassed on average more than 21,000 German seamen per year. It served as a source for comparison with the official national database on discharge diagnoses from the general German population. Thus, the standardised hospitalisation ratio (SHR) could be calculated.

**Results:** During the above mentioned time period, the most prominent non-cancer diagnoses among seafarers were diseases of the circulatory system, diseases of the digestive system, diseases of the musculoskeletal system, as well as injury and poisoning. Compared to the reference population, decreased SHRs were observed for almost all examined diseases with the exception of asbestosis (SHR: 1.79; 95% CI 0.65–3.90). In contrast to the deck and engine room crew, the galley staff demonstrated an increased SHR for almost all examined diseases, particularly for lifestyle-related diseases.

**Conclusions:** Although the presented data are likely biased by the healthy worker effect and by underreporting due to treatment on board or abroad, an elevated SHR for (lifestyle-related) diseases was observed in the galley staff. Therefore, especially this occupational group seems to need specific advice on healthy behaviours both on board and ashore.

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**Key words:** hospitalisation, non-cancer, seafarers, lifestyle, health hazards

## INTRODUCTION

It has been repeatedly described that the seafarer's job is associated with numerous occupational risks, fatigue, isolation, high physical demands and an elevated stress level on board [1, 2]. Particularly their risk for accidents at the workplace is increased compared to that of employees ashore [3]. The unique living and working situation of seafarers can also lead to emotional and physical exhaustion as well as to work-related diseases [4].

Diesel exhaust emissions from vessels contain toxic air contaminants (sulphur dioxide [SO<sub>2</sub>], nitrogen oxides [NO<sub>x</sub>]) and particulate components. When released into

the atmosphere, these fine particles can cause acute short-term symptoms such as headache, coughing, difficult or laboured breathing, tightness of chest, and irritation of the eyes and nose. Seafarers with long-term exposures to diesel exhaust are at risk for chronic, serious health problems such as cardiovascular disease, cardiopulmonary disease and lung cancer [5]. Besides diesel exhaust, the occupational exposure to toxic substances in shipboard working materials (paints, solvents) or in transported goods (benzene) can constitute a risk factor for acute or chronic diseases [6–8].

A recent German study on hospitalisation of German seafarers due to cancer revealed an elevated standardised

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hospitalisation ratio (SHR) for malignant neoplasms at all sites, for leukaemia, non-Hodgkin lymphoma, for respiratory cancer, and for non-melanoma skin cancer [9]. In contrast, this study estimates the SHR due to non-cancer diseases in German seafarers employed on German vessels. The knowledge about the prevalence of diseases among seafarers is a crucial precondition for specific prevention on board. Up to now, however, no study has been conducted on the frequencies of non-cancer diseases requiring admission to hospital among German seafarers.

## MATERIALS AND METHODS

In Germany, all German seafarers working on German-flagged vessels were compulsorily insured with the health insurance company for seafarers up to January 2008. Therefore, the insurance company registered all hospitalisations of these seafarers in their database up to this date. In this study, this database served as information source for the seafarers' hospital admissions; the first discharge diagnoses were evaluated for all German seafarers treated in German hospitals from January 1997 to December 2007. Furthermore, this survey included only those German seamen who had been employed over cumulatively more than 365 seafaring days on board a German-flagged vessel in the above-mentioned time period. On average, more than 21,000 German seamen were included per year (13,965 deck crew, 5,930 engine room crew and 1,828 galley staff).

On the basis of our available pivot tables about seafarers' hospitalisation, it was possible to analyse the hospital admissions in consideration of the seamen's current occupational shipboard group (deck crew, engine room crew and galley personnel) and vessel at the end of each year within the examination period. Thus, the seamen were annually assigned to their past shipboard jobs and vessel types per year

The competent ethic commission approved this study.

The first discharge diagnosis of each patient who had been admitted to German hospitals is also recorded in the national hospital statistics for the population of the Federal Republic of Germany. These statistics are carried out jointly by the statistical offices of the German Government and the Federal States as an annual total compulsory survey (<https://www.gbe-bund.de/>). All German hospitals in Germany are included in this survey. The hospitals provide patient-related characteristics and the main diagnosis of hospitalisation.

In consideration of the different age distribution in each year of the examination period, the seamen's hospitalisations due to non-cancer diagnoses were compared with those of the general German male population in the same time period. Thus, the seafarers' risk for non-cancer diseases could be expressed as indirect age and calendar time SHR [9, 10]. In detail, as numerator the observed number was the total number of the first hospitalisations from each

diagnosis in the cohort of seamen during the period under observation. The expected number – as denominator – was the number of seamen in each age group (age groups 15–24, 25–34, 35–44, 45–54, 55–64, 65–74 years and older than 75 years) for each examination year multiplied with the respective age-, and calendar period-specific hospitalisations rate in the national cohort. The SHR was calculated by division of the observed number with the expected number based on standard procedures of standardised mortality ratio (SMR) or standardised incidence ratio (SIR) [11].

Confidence intervals (95% CI) were calculated according to the Byar method. All calculations were performed with IBM SPSS Statistics 20.0 (2012) and Microsoft Excel (2010).

## RESULTS

Out of the available ICD-9 main categories for non-cancer diagnoses, diseases of the circulatory system ( $n = 13,581$ ), diseases of the digestive system ( $n = 6,924$ ), diseases of the musculoskeletal system and connective tissue ( $n = 5,077$ ), injury and poisoning ( $n = 4,818$ ) as well as diseases of the respiratory system ( $n = 3,217$ ), in decreasing order, were most frequently found among seafarers (Table 1). Referring to the selected sub-categories, ischaemic heart diseases ( $n = 4,852$ ) as well as diabetes mellitus ( $n = 958$ ) dominated in the examined seafaring population.

Compared to the reference population, decreased SHRs – mostly on a significant level – were observed for diseases of the circulatory (hypertensive/ischaemic heart diseases, chronic pulmonary heart disease), digestive (ulcers as well as endocrine/nutritional disorders, diabetes mellitus), musculoskeletal, genitourinary and respiratory (emphysema, asthma) systems as well as for infectious or parasitic diseases. According to the present data, the risk for injury and poisoning was also not elevated among German seafarers (Table 1).

After distinguishing between the different types of vessels, the crews on fishing vessels had a significantly increased SHR for injury and poisoning compared to the other seamen (SHR 1.23; 95% CI 1.13–1.33 vs. SHR 0.89; 95% CI 0.87–0.92; data not shown). Additionally, a slightly increased SHR for diseases of the musculoskeletal system was found among fishermen, compared to a decreased SHR among the other seamen (SHR 1.08; 95% CI 0.99–1.19 vs. SHR 0.89; 95% CI 0.87–0.92; data not shown).

In respect of the different occupational shipboard groups, the galley staff demonstrated – in contrast to the other both occupational groups – an increased SHR for almost all examined diseases, especially for lifestyle-related diseases (endocrine, nutritional and metabolic diseases, respiratory [asthma] and digestive diseases [e.g. diabetes mellitus, gastric ulcer]) (Table 2). The galley staff also had a significantly elevated SHR for injuries and poisoning as well as for infectious and parasitic diseases.

**Table 1.** Standardised hospitalisation ratios (SHR) for selected non-cancer diagnoses among male German seafarers in the period 1997–2007

Diagnosis (ICD-9 code)	Observed number	Expected number	SHR	(95% CI)
<b>Diseases of the circulatory system (390-459)</b>	13,581	15,177.0	<b>0.89</b>	(0.88–0.91)
Hypertensive disease (401-405)	602	792.1	<b>0.76</b>	(0.70–0.82)
Ischaemic heart disease (410-414)	4,852	6,093.2	<b>0.80</b>	(0.77–0.82)
Chronic pulmonary heart disease (416)	29	35.4	0.82	(0.55–1.18)
<b>Diseases of the digestive system (520-579)</b>	6,924	7,220.9	<b>0.96</b>	(0.94–0.98)
Gastric, duodenal and peptic ulcers (531-533)	389	389.0	1.00	(0.90–1.10)
<b>Diseases of the musculoskeletal system and connective tissue (710-739)</b>	5,077	5,604.5	<b>0.91</b>	(0.88–0.93)
<b>Injury and poisoning (800-999)</b>	4,818	5,220.0	<b>0.92</b>	(0.90–0.95)
<b>Diseases of the genitourinary system (580-629)</b>	3,316	3,487.7	<b>0.95</b>	(0.92–0.98)
<b>Diseases of the respiratory system (460-519)</b>	3,217	3,514.1	<b>0.92</b>	(0.88–0.95)
Emphysema (492)	16	27.8	<b>0.58</b>	(0.33–0.94)
Asthma (493)	74	89.9	0.82	(0.65–1.03)
Asbestosis (501)	6	3.4	1.79	(0.65–3.90)
<b>Endocrine, nutritional and metabolic diseases, and immunity disorders (240-279)</b>	1,487	1,702.5	<b>0.87</b>	(0.83–0.92)
Diabetes mellitus (250)	958	1011.7	0.95	(0.89–1.01)
<b>Infectious and parasitic diseases (1-139)</b>	877	991.2	<b>0.88</b>	(0.83–0.95)

Significant results are bold. CI – confidence interval

## DISCUSSION

At sea, seafarers experience high physical demands such as rough seas, storm, cold and operating heavy equipment on a slippery deck. Thus, seafaring requires great effort from the body and muscles [12]. Furthermore, ship crews are exposed to a high level of psycho-social stress that may also enhance their known increased risk for occupational accidents and injuries [13, 14]. Therefore, an elevated SHR for injury and poisoning was expected among seafarers compared to the reference population. In this study, however, this risk was slightly decreased in the total group. When distinguishing between the types of vessels, the crews on fishing vessels showed a slightly increased SHR for injuries that is likely explained by their handling heavy fishing gear on deck and by the fish processing activities at sea over several hours per day [10].

In addition, it was assumed that ship movements during voyages – especially on smaller vessels like fishing boats – can cause musculoskeletal diseases. In line with the findings from Hansen et al. [3], however, this study demonstrated a decreased SHR for diseases of the musculoskeletal system among seamen (with the exception of fishermen).

The present study revealed that diseases of the circulatory and digestive systems were the most prominent health disorders leading to hospitalisation among seafarers. Compared to the German reference population, seamen showed a significantly decreased risk for these diseases

(with the exception of the galley personnel). Particularly the low risk for diseases of the circulatory system among seafarers was surprising; typical shipboard malnutrition combined with an increased proportion of smokers, the lack of exercise and high job-related stress on board are crucial contributory risk factors for cardiovascular diseases in seafaring [15, 16]. Shift work and especially irregular working hours (which are typical in seafaring) may also lead to an increased hospitalisation risk for cardiovascular diseases in seafarers [17]. Among Danish seafarers, even elevated cardiovascular mortality was found that was supposed to be mainly caused by their shipboard lifestyle [18]. The hospitalisation study by Hansen et al. [3], however, also confirmed a lower SHR for acute myocardial infarction among seafarers in accordance with the present study results. These findings can be mainly interpreted as a healthy-worker effect due to the biennial medical fitness examinations in seafaring.

In the light of the known high tobacco consumption among seafarers [19–22], an elevated SHR for respiratory diseases was expected. Furthermore, seafarers are exposed at their working place to a variety of materials with harmful effects on their airways – ranging from organic solvents and mineral oils to exhaust gases, asbestos and a variety of hazardous cargoes [19]. Consequently, an increased incidence of respiratory diseases among seafarers was assumed. In this study, however, apart from the galley staff

**Table 2.** Standardised hospitalization ratios (SHR) for selected non-cancer diagnoses among male German seafarers in the period 1997–2007

Diagnosis (ICD-9 code)	SHR (95% CI) [O: observed; E: expected]		
	Deck crew	Engine room crew*	Galley personnel
<b>Diseases of the circulatory system (390-459)</b>	<b>0.91 (0.89–0.93)</b> O: 8,400; E: 9,200.4	<b>0.82 (0.79–0.84)</b> O: 3,657; E: 4,475.5	<b>1.13 (1.07–1.20)</b> O: 1,232; E: 1,087.5
Hypertensive disease (401-405)	<b>0.74 (0.66–0.82)</b> O: 352; E: 477.7	<b>0.76 (0.65–0.88)</b> O: 176; E: 233.1	1.02 (0.78–1.32) O: 59; E: 57.6
Ischaemic heart disease (410-414)	<b>0.84 (0.81–0.87)</b> O: 3,086; E: 3,682.5	<b>0.71 (0.67–0.75)</b> O: 1,282; E: 1,804.3	<b>0.90 (0.81–0.99)</b> O: 394; E: 437.8
<b>Diseases of the digestive system (520-579)</b>	0.98 (0.95–1.01) O: 4,246; E: 4,338.4	<b>0.83 (0.79–0.87)</b> O: 1,736; E: 2,082.5	<b>1.31 (1.22–1.41)</b> O: 707; E: 539.0
Gastric, duodenal and peptic ulcers (531-533)	1.01 (0.89–1.15) O: 238; E: 235.4	0.85 (0.69–1.04) O: 96; E: 113.0	<b>1.55 (1.12–2.08)</b> O: 44; E: 28.4
<b>Diseases of the musculoskeletal system and connective tissue (710-739)</b>	<b>0.90 (0.86–0.93)</b> O: 2,998; E: 3,347.4	<b>0.88 (0.83–0.93)</b> O: 1,423; E: 1,620.0	<b>1.11 (1.02–1.22)</b> O: 473; E: 424.8
Injury and poisoning (800-999)	<b>0.90 (0.87–0.94)</b> O: 2,812; E: 3,120.1	<b>0.89 (0.84–0.94)</b> O: 1,286; E: 1,447.5	<b>1.21 (1.11–1.33)</b> O: 488; E: 402.1
<b>Diseases of the genitourinary system (580-629)</b>	<b>0.94 (0.90–0.98)</b> O: 1,988; E: 2,109.3	<b>0.91 (0.85–0.97)</b> O: 922; E: 1,011.1	<b>1.25 (1.11–1.39)</b> O: 318; E: 255.1
<b>Diseases of the respiratory system (460-519)</b>	<b>0.92 (0.88–0.96)</b> O: 1,964; E: 2,130.2	<b>0.84 (0.78–0.90)</b> O: 843; E: 1,004.7	<b>1.21 (1.08–1.35)</b> O: 312; E: 257.3
Asthma (493)	0.85 (0.62–1.13) O: 46; E: 54.1	<b>0.51 (0.27–0.87)</b> O: 13; E: 25.5	<b>1.94 (1.03–3.31)</b> O: 13; E: 6.5
<b>Endocrine, nutritional and metabolic diseases, and immunity disorders (240-279)</b>	<b>0.76 (0.71–0.82)</b> O: 783; E: 1,025.5	<b>0.84 (0.77–0.93)</b> O: 420; E: 497.6	<b>1.75 (1.53–2.00)</b> O: 219; E: 124.8
Diabetes mellitus (250)	<b>0.78 (0.71–0.85)</b> O: 475; E: 609.9	0.93 (0.82–1.04) O: 275; E: 296.6	<b>2.18 (1.86–2.54)</b> O: 161; E: 73.8
<b>Infectious and parasitic diseases (1-139)</b>	<b>0.81 (0.74–0.88)</b> O: 483; E: 597.6	<b>0.82 (0.72–0.94)</b> O: 231; E: 280.6	<b>1.77 (1.48–2.10)</b> O: 131; E: 74.0

\*Without ship mechanics (with normally changing workplaces). Significant results are bold. CI – confidence interval

an elevated SHR for asthma was not observed. It is unclear whether the observed lower SHR for asthma among deck and engine room crew might be caused by the fresh climate at sea, which is low in allergens.

Furthermore, the SHR for asbestosis was increased in this study. Asbestos had been introduced into ship construction in the late 19<sup>th</sup> century and was used as insulation material until the mid-1990s. During the lifetime of a ship, heat and aging of the asbestos insulation products lead to increased friability whereby natural movements and vibrations of the ship's structure enhanced fibre release. It is assumed that particularly engine personnel have repeated exposure to asbestos during running repairs [23]. In this study, although only a few patients with asbestosis had been determined (mostly among technical officers on tankers or cargo ships), these hospitalisations can be regarded as an occupational-related disease [19].

Moreover, owing to the ships' stays in ports with lower hygienic standards, a higher SHR for infectious or parasitic diseases was expected among seafarers. In the present study, however, this was only observed among the galley

staff. According to the entries documented in 49 medical log books from seagoing cargo ships under German flag, nearly one fourth of the visits to the ship's infirmary were due to presumably communicable diseases, indicating the high relevance of infectious diseases in seafaring [24]. In cases of health problems aboard, seafarers can use the ship's infirmary and be treated by the ship's officer in charge of medical care. Thus, some – particularly acute – diseases may only be treated at sea and are consequently not counted in hospitalisation statistics. Therefore, it cannot be excluded that treatment at sea had diminished the hospitalisation ratios among seafarers. In addition, some seamen might conceal their shipboard health problems requiring hospitalisation to avoid an expected subsequent relief on board.

In accordance with a survey of Hansen et al. [3], the galley staff in this study showed an increased SHR particularly for lifestyle-related diseases such as nutritional (e.g. diabetes), airway and gastrointestinal diseases as well as injuries. Lifestyle-related diseases are assumed to be caused by malnutrition, tobacco smoking, alcohol consumption, high

stress, lack of exercises and risky behaviour. Several of these risk factors are observed among galley and catering crew as high-calorie food is always available in mess rooms and eating is one of the most favoured activities in leisure time on board. Previous studies observed that the galley staff is often less qualified than deck and engine room personnel, indicating a lower socioeconomic status with a consequently higher risk for lifestyle-related diseases [25, 26].

### LIMITATIONS OF THE STUDY

As a limitation of this study, the biennial medical fitness tests for seafarers constitute a healthy worker effect. Furthermore, some health disorders at sea can be appropriately managed on board or treated without urgent hospitalisation and were not registered in the seafarer database. Both aspects could have led to an underestimation of disease frequencies among seafarers; furthermore, the treatments in hospitals abroad were not registered in this study. However, it is likely that many seafarers with severe health diseases were referred to a German hospital in the course of time [15].

Acute health disorders in seafarers can be caused both by their job-related exposure (e.g. kind and frequency of contact with hazardous substances, stress level on board) and by lifestyle-related behaviour (smoking, alcohol). Unfortunately, data on these hazards are not available in this study. Thus, it is impossible to determine to what extent the seafarers' decreased SHR for most of the examined non-cancer diseases was attributed to their job-related hazards. In the light of the observed elevated SHR for lifestyle-related diseases among the galley staff, this occupational group seems to need specific advice on healthy behaviours.

### CONCLUSIONS

In total, further studies are needed to elucidate the risk of seafarers for non-cancer diagnosis, taking into consideration the job-related exposure as well as their lifestyle-related behaviour.

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### AUTHORSHIP

M. Oldenburg, U. Manuwald and V. Harth were involved in conception, discussion and design of this manuscript. U. Manuwald made the statistical analysis. M. Oldenburg interpreted the data and wrote the paper.

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