Hospital contacts due to cardiovascular and respiratory diseases and neoplasms among seafarers compared to farmers: a Danish register-based cohort study

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Abstract

Background Seafaring has an occupational environment with many health risks. On the other hand, regular medical examinations are mandatory to get permission for working onboard. The present study examined incidence of neoplasms, cardiovascular and respiratory diseases among Danish seafarers compared with farmers, as a relevant land-based trade.

Methods The participants were all seafarers or farmers aged 18-65 years at the baseline and residing in Denmark. Two cohorts with baselines in 2002 (n=56,216) and 2012 (n=42,000) were linked to records from Danish health registers. We calculated incident rates and the hazard ratios of hospital contacts using Cox regression models separately for men and women.

Results In all disease categories, the risk for hospital contact was higher among male seafarers compared with male farmers. The adjusted hazard ratios for the 2012 cohort for neoplasms, cardiovascular and respiratory diseases were 1.36 (95% CI: 1.17 to 1.58), 1.16 (95% CI: 1.01 to 1.32), and 1.51 (95% CI: 1.28 to 1.78), respectively. Among female seafarers, the hazard ratio for the 2012 cohort for respiratory diseases was 1.58 (95% CI: 1.18 to 2.10), but for cardiovascular diseases 0.73 (95% CI: 0.54 to 0.99). Between the 2002 and 2012 cohort, the incident rates and differences decreased in cardiovascular diseases and increased in neoplasms and respiratory diseases, particularly in men.

Conclusions Findings of this register-based cohort study suggest that, regardless of mandatory and regular medical examinations, seafaring is associated with a substantially increased risk of respiratory diseases in both sexes, and neoplasms and cardiovascular diseases among men.

Introduction
Cardiovascular disease (CVD), chronic respiratory disease and cancer are major non-communicable diseases (NCDs) associated with around 70% of the deaths worldwide [1]. A substantial amount of the NCD burden is attributable to behavioural, dietary, environmental, and metabolic risk factors [2, 3]. CVD and malignant neoplasms share many risk factors, such as smoking, harmful alcohol consumption, low fruit and vegetable intake, obesity, physical inactivity, stress, shift work [3, 4]. For chronic obstructive pulmonary disease (COPD), the major respiratory disease in terms of morbidity and mortality, tobacco smoking is the leading risk factor, accounting for 80% of the disease burden [5], but approximately 10-15% is likely to be work related, such as from occupational exposures to vapours, gases, dust and fumes [5-7].

Seafaring is a special occupational environment with exposure to many occupational but also lifestyle health risks related to cardiovascular and respiratory diseases and malignant neoplasms. High levels of modifiable risk factors for CVDs among seafarers include diet, lack of exercises on board and tobacco smoking [8]. Furthermore, the employment in the maritime sector is related to many psychosocial stressors, such as long-time separation from the family, long working hours, continuously changing crews, reduced duration and poor quality of sleep [9]. Permanent physical risk factors such as ship movements, noise and vibration are inherently part of the seafaring working environment [9]. Seafarers are also exposed to hazardous, often carcinogenic, substances [10, 11].

Findings from previous research on neoplasms, cardiovascular and respiratory diseases among seafarers are conflicting. Seafarers have been found to have elevated [12, 13] or lower [14] risk for these diseases, or the risk has been equivalent [12, 13] to those of the comparison group. Inconsistent results may be accounted for by the choice of different comparison groups [15]. Instead of using the general population or economic active general population as the reference group, as it was used in these previous studies, a
relevant external comparison group may be used to avoid problems, such as healthy worker effect, arising when using the general population as the reference group. [15, 16]. According to previous research from Nordic countries, agriculture, a firmly land-based trade as opposed to seafaring, can be regarded as an average among industries in terms of health outcomes. Danish farmers had longer expected lifetime in perceived good health than unskilled men but shorter than high-level salaried employees [17]. Farmers in Norway had an increased risk for disability pension than higher grade professionals or non-manual occupations but a lower risk than other manual occupations [18, 19]. Danish farmers and self-employed had elevated risk for all-cause mortality and CVD mortality than upper non-manual workers but this risk was lower when compared with manual workers [20].

The aim of this study was, therefore, to examine incidence of CVDs, neoplasms and respiratory diseases among seafarers, and estimate the relative risk of incidence compared with farmers in Denmark, and to identify changes over a decade.

Methods

Study and reference population

This is a register-based cohort study. The study population constitutes all seafarers with a permanent address in Denmark aged 18-65 years at the baseline of 2002 and 2012. As employees, including seafarers, are normally characterized by being healthier than the general population [21, 22], an external occupation reference group, namely people working in agriculture, was used to reduce a potential healthy worker effect. The two cohorts of seafarers and farmers in 2002 and 2012 consisted of 56,216 and 42,000 individuals, respectively.

Data sources

All data were obtained by the linkage of Danish national registers. The Danish Civil
Registration System was established in 1968 and comprises information on all live-born children and new residents in Denmark, who are assigned a Civil Personal Register (CPR) number [23]. The CPR-number is used to register utilization of healthcare services, and it enables Statistics Denmark to carry out the data linkage between various data sources at individual level. Data on the health-related outcomes were obtained from the Danish National Hospital Register and the Cause of Death Register. The Danish National Patient Register contains information on all in- and outpatient, and emergency contacts for all hospitals in Denmark.

All registers have full national coverage, and information from the registers are anonymized when used for research. The study was approved by the Danish Data Protection Agency. Informed formal consent was not required due to the nature of the data.

**Health outcomes**

Hospital contacts were defined as either an inpatient admission, an outpatient contact, or an emergency contact, and they were used as a proxy measure for disease incidence of interest. Outcomes were identified with the use of codes in the International Classification of Diseases, 10th Revision and included hospital contacts from diseases of the circulatory system (I00–28, I30–51, I60–99), neoplasms (C00–97, D00–48), and diseases of the respiratory system (J00–99).

The follow-up began on January 1 at the beginning of both cohorts and ended on the day the participant was hospitalized, died or emigrated. For the rest of the participants, the follow-up period ended 5 years after it began, on December 31 (mean follow-up time 4.7 years).

**Covariates**

Age was used as a continuous variable. Occupational class was divided into two
categories. The first category included work requiring skills at the highest level and self-employed individuals with employees. The second category included self-employed individuals without employees, work requiring skills at the intermediate or basic level, other employees or employees without information on job level. Income was measured as the personal disposable income after taxes and transfers and was used as a continuous variable.

**Statistical analysis**

We compared the characteristics of participants according to the trade using t-tests or Chi square tests. Age-adjusted incidence rates per 1,000 person-years for the three diagnostic categories of hospital contacts were calculated in both five-year cohorts. For every individual within both cohorts, only the first hospital contact for the given diagnostic category was included and the individual was then removed from the risk population. We did not exclude individuals’ subsequent hospital contacts for other diagnostic categories. Individuals who died or moved out from Denmark were removed from the risk population. We calculated proportional hazard ratios with 95% confidence intervals (CIs) from Cox regression models to assess relative differences in the three diagnostic categories of hospital contacts between seafarers and farmers. We adjusted these models for age, social class and income. We also performed analyses by using squared age term as covariates. However, the estimates were little changed. All analyses were conducted separately for men and women. Data were analyzed using Stata statistical software, version MP 15.1.

**Results**

**Descriptive results**

Descriptive baseline characteristics of the study population of seafarers and farmers in the two cohorts are presented in Table 1. The two cohorts of 2002 and 2012 comprised
56,212 and 42,000 individuals, respectively. In the male and female study population, there were relatively more farmers than seafarers belonging to the age group 50 years or older, whereas there were more seafarers than farmers in the age group of 30 to 39 years. Seafarers had higher disposable personal income in average. The overall pattern of baseline characteristics and differences between seafarers and farmers did not change much across time. However, a clear shift from lower to higher occupational class occurred among seafarers, and especially among female seafarers. Furthermore, disposable personal income among seafarers increased relatively more than among farmers.
Table 1. Baseline characteristics of seafarers and farmers in two cohorts of 2002 and 2012.

|                  | Cohort 2002 | Cohort 2012 |
|------------------|-------------|-------------|
|                  | Seafarers   | Farmers     |
|                  | n = 9,451   | n = 46,765  |
|                  | Seafarers   | Farmers     |
|                  | n = 6,987   | n = 35,013  |
| **Men**          |             |             |
| Age, years       |             |             |
| 18-29            | 2,215 (27)  | 8,164 (24)  |
|                  | 1,113 (21)  | 7,959 (29)  |
| 30-39            | 2,241 (28)  | 7,340 (22)  |
|                  | 1,612 (30)  | 4,643 (17)  |
| 40-49            | 1,640 (20)  | 7,289 (22)  |
|                  | 1,366 (25)  | 6,055 (22)  |
| 50-65            | 2,011 (25)  | 11,030 (33) |
|                  | 1,327 (24)  | 8,579 (32)  |
| **Occupation**   |             |             |
| Higher           | 1,336 (16)  | 6,477 (19)  |
|                  | 1,133 (21)  | 4,820 (18)  |
| Lower            | 6,771 (84)  | 27,346 (81) |
|                  | 4,285 (79)  | 22,416 (82) |
| **Income**       | 241 (158)   | 132 (277)   |
|                  | 469 (1517)  | 217 (723)   |
| **Follow-up, years** | 4.7 (1.0)  | 4.7 (1.0)   |
|                  | 4.7 (1.0)   | 4.7 (1.0)   |
| **Women**        |             |             |
| Age, years       |             |             |
| 18-29            | 569 (42)    | 3,625 (25)  |
|                  | 436 (28)    | 2,975 (38)  |
| 30-39            | 380 (28)    | 2,848 (22)  |
|                  | 630 (40)    | 1,437 (18)  |
| 40-49            | 213 (16)    | 2,517 (21)  |
|                  | 313 (20)    | 1,570 (20)  |
| 50-65            | 182 (14)    | 3,952 (31)  |
|                  | 190 (12)    | 1,795 (23)  |
| **Occupation**   |             |             |
| Higher           | 40 (3)      | 3,835 (30)  |
|                  | 429 (27)    | 1,694 (22)  |
| Lower            | 1,304 (97)  | 9,107 (70)  |
|                  | 1,140 (73)  | 6,083 (78)  |
| **Income**       | 173 (76)    | 124 (107)   |
|                  | 315 (181)   | 174 (444)   |
| **Follow-up, years** | 4.7 (0.9)  | 4.6 (1.1)   |
|                  | 4.6 (1.0)   | 4.6 (1.0)   |

Values are n (%), except mean (± SD) for income and follow-up. Income refers to personal disposable income in thousands Danish crowns. Comparisons between the trades were done with 2-sample Student t tests or chi-square test, as appropriate. All p-values are <0.001, except p=0.005 in comparison of duration of follow-up between the trades in men in the 2002 cohort and p=0.040 in men and 0.593 in women in the 2012 cohort.
Associations and incidence rates in men

Figure 1 shows the age-adjusted incidence rates and Table 2 the results of the Cox regression models for the association between trades and hospital contacts for CVDs, neoplasms and respiratory diseases among men in the cohort 2002 and cohort 2012.

Incidence rates of CVDs decreased by 19% from 10.8 [95% confidence intervals (CI): 9.9, 11.8] to 8.8 (95% CI: 7.9, 9.9) hospital contacts per 1,000 person-years among seafarers and by 9% from 9.3 (95% CI: 9.9, 11.8) to 8.5 (95% CI: 8.1, 8.9) among farmers.

|                 | Hospital contacts | Model 1 | Model 2 | Model 3 |
|-----------------|-------------------|---------|---------|---------|
|                 |                   | Hazard  | 95% CI  | Hazard  | 95% CI  | Hazard  | 95% CI  |
|                 |                   | ratio   |         | ratio   |         | ratio   |         |
| **Cohort 2002**|                   |         |         |         |         |         |         |
| Cardiovascular  | Farmers           | 1.00    | 1.17, 1.42 | 1.00    | 1.16, 1.41 | 1.00    | 1.18, 1.47 |
| disease         | Seafarers         | 1.29    | 1.17, 1.42 | 1.28    | 1.16, 1.41 | 1.32    | 1.18, 1.47 |
| Neoplasm        | Farmers           | 1.00    | 1.16, 1.52 | 1.00    | 1.16, 1.52 | 1.00    | 1.16, 1.52 |
|                 | Seafarers         | 1.33    | 1.16, 1.52 | 1.33    | 1.16, 1.52 | 1.32    | 1.18, 1.47 |
| Respiratory     | Farmers           | 1.00    | 1.08, 1.42 | 1.00    | 1.06, 1.40 | 1.00    | 1.06, 1.40 |
| disease         | Seafarers         | 1.24    | 1.08, 1.42 | 1.22    | 1.06, 1.40 | 1.22    | 1.06, 1.40 |
| **Cohort 2012**|                   |         |         |         |         |         |         |
| Cardiovascular  | Farmers           | 1.00    | 1.00, 1.28 | 1.00    | 1.00, 1.28 | 1.00    | 1.00, 1.28 |
| disease         | Seafarers         | 1.13    | 1.00, 1.28 | 1.13    | 1.00, 1.28 | 1.13    | 1.00, 1.28 |
| Neoplasm        | Farmers           | 1.00    | 1.00     | 1.00    | 1.00     | 1.00    | 1.00     |
|                 | Seafarers         | 1.41    | 1.23, 1.62 | 1.41    | 1.22, 1.61 | 1.41    | 1.22, 1.61 |
| Respiratory     | Farmers           | 1.00    | 1.00     | 1.00    | 1.00     | 1.00    | 1.00     |
| disease         | Seafarers         | 1.49    | 1.29, 1.73 | 1.49    | 1.29, 1.73 | 1.49    | 1.29, 1.73 |

Model 1: adjusted for age. Model 2: adjusted for age and social class. Model 3: adjusted for age, social class and income.

The age-adjusted hazard ratio (HR) for CVDs among seafarers in cohorts 2002 and 2012 were 1.29 (95% CI: 1.17, 1.42) and 1.13 (95% CI: 1.00, 1.28). The corresponding HRs after further adjusting for social class and income were 1.32 (95% CI: 1.18, 1.47) and 1.16 (95% CI: 1.01, 1.32), respectively.

Incidence rates increased both for neoplasms and respiratory diseases and in both trades...
but more markedly among seafarers which resulted in higher HRs in the 2012 than in the 2002 cohort. Incidence rates for neoplasms increased by 35% from 5.5 (95% CI: 4.8, 6.2) to 7.4 (95% CI: 6.5, 8.3) among seafarers and by 30% from 4.4 (95% CI: 4.1, 4.7) to 5.7 (95% CI: 5.4, 6.0) among farmers, whereas incidence rates for respiratory diseases increased by 23% from 5.2 (95% CI: 4.6, 5.9) to 6.4 (95% CI: 5.6, 7.3) among seafarers and by 8% from 4.0 (95% CI: 3.8, 4.3) to 4.3 (95% CI: 4.0, 4.6) among farmers. The HRs of full models for neoplasms in cohorts 2002 and 2012 were 1.25 (95% CI: 1.08, 1.45) and 1.36 (95% CI: 1.17, 1.58), respectively, whereas the full-model HRs for respiratory diseases were 1.30 (95% CI: 1.12, 1.52) and 1.51 (95% CI: 1.28, 1.78), respectively.

Associations and incidence rates in women

Figure 2 and Table 3 show the corresponding age-adjusted incidence rates and results from the Cox regression models among women. Incidence rates of CVDs decreased by 18% from 7.6 (95% CI: 5.7, 10.0) to 6.2 (95% CI: 4.8, 8.0) among female seafarers and equally by 18% from 10.0 (95% CI: 9.4, 10.8) to 8.2 (95% CI: 7.5, 9.1) among female farmers. The HRs from the full model for CVDs in cohorts 2002 and 2012 were 0.70 (95% CI: 0.51, 0.94) and 0.73 (95% CI: 0.54, 0.99), respectively.
| Hospital contacts | Model 1 | | Model 2 | |
|---|---|---|---|---|
| | Hazard ratio | 95% CI | Hazard ratio | 95% CI |
| Cohort 2002 | | | | |
| Cardiovascular disease | | | | |
| Farmers | 823 | 1.00 | 1.00 | |
| Seafarers | 47 | 0.75 | 0.56, 1.01 | 0.77, 1.04 |
| Neoplasm | | | | |
| Farmers | 691 | 1.00 | 1.00 | |
| Seafarers | 69 | 1.27 | 0.99, 1.63 | 1.31, 1.69 |
| Respiratory disease | | | | |
| Farmers | 378 | 1.00 | 1.00 | |
| Seafarers | 33 | 0.88 | 0.61, 1.25 | 0.86, 1.23 |
| Cohort 2012 | | | | |
| Cardiovascular disease | | | | |
| Farmers | 398 | 1.00 | 1.00 | |
| Seafarers | 58 | 0.77 | 0.59, 1.02 | 0.77, 1.02 |
| Neoplasm | | | | |
| Farmers | 450 | 1.00 | 1.00 | |
| Seafarers | 105 | 1.18 | 0.95, 1.46 | 1.18, 1.46 |
| Respiratory disease | | | | |
| Farmers | 243 | 1.00 | 1.00 | |
| Seafarers | 88 | 1.71 | 1.34, 2.18 | 1.70, 2.18 |

Model 1: adjusted for age. Model 2: adjusted for age and social class. Model 3: adjusted for age, social class and income.

The change of 1% in incidence rate of neoplasm, from 11.2 (95% CI: 8.8, 14.1) to 11.3 (95% CI: 9.3, 13.7), was marginal among female seafarers, whereas there was an increase among female farmers of 11% from 8.4 (95% CI: 7.8, 9.1) to 9.3 (95% CI: 8.5, 10.2). The incidence rate of respiratory diseases increased markedly by 79% among female seafarers from 5.2 (95% CI: 3.7, 7.4) to 9.3 (95% CI: 7.6, 11.5), whereas the increase was only 9%, from 4.5 (95% CI: 4.1, 5.0) to 4.9 (95% CI: 4.3, 5.6), among female farmers. The HR adjusted for age and social class for neoplasms was 1.31 (95% CI: 1.02, 1.69) in the 2002 cohort but further adjusting for income attenuated the association. The HR from the full model for respiratory diseases was 1.58 (95% CI: 1.18, 2.10) in the 2012 cohort.
Discussion

We found that male seafarers had a higher risk for hospital contact from CVDs, neoplasms and respiratory diseases compared with male farmers. Female seafarers of the 2012 cohort had a higher risk for respiratory diseases than the corresponding female farmers, whereas they had a lower risk for CVDs both in 2002 and 2012 cohorts. The incident rates and differences between seafarers and farmers decreased in CVDs and increased in neoplasms and respiratory diseases, particularly in men, between the 2002 and 2012 cohorts.

Compared to other studies

In our study, an increased risk for CVDs was found in male seafarers, while previous evidence on the risk for CVDs is somewhat conflicting. A Danish study found that non-officers had 1.3 and 1.2-fold higher risk for CVDs in two cohorts of 1994 and 1999 when compared to the national rates among economically active people in the entire Danish population [13], whereas risk among officers was marginal in the two cohorts from 1994 and 1999. In comparison to the general male German population, a 10% lower risk for CVDs was observed among male German seafarers [14]. However, in the differentiated analysis according to occupation on board, the galley staff demonstrated a 10% higher risk for CVDs [14]. The lower risk among German seafarers compared to the general population may be largely attributable to bias arising from the healthy-worker effect. In contrast to our present findings of a lower risk for CVDs among female seafarers, an earlier Danish study based on data from mid-1990’s reported an increased risk [13]. This difference may reflect the overall declining trend in incident of CVDs which could be more pronounced among seafarers, although our study demonstrated a decline of 18% in the incident rates in both occupational groups.

The finding of the elevated risk for respiratory diseases in seafarers is in contrast to a
recent study which found that male German seafarers had 8% lower risk for respiratory diseases compared to the general male German population [14], but again, the galley staff had 1.2-fold higher risk for all respiratory diseases and 1.9-fold higher risk for asthma. Our findings are somewhat in line with an earlier Danish study which found 14% higher risk for non-officers but decreased risk for officers [13]. A recent large population-based UK Biobank cohort study including selected occupations found that seafarers had 2.6-fold higher risk for COPD compared with populations not working in this specific job, and that this increased risk did not decrease when only never-smokers were included in the analysis [24]. Our finding that female seafarers had a 60% higher risk for respiratory diseases in the 2012 cohort is much higher than findings from a previous Danish study [13]. It is also notable that the increase in incidence rates was 79% in female seafarers versus 9% in female farmers. The reasons for this increase in incidence of respiratory diseases is unclear but they might involve changes in health-behaviour, especially an increased prevalence of smoking among female seafarers, or/and increased workplace exposure to chemical hazards.

The incidence of neoplasm in our study are close to those reported earlier regardless of the differences in comparison groups and whether neoplasms consist of just malignant or all types of neoplasms. Three previous Danish studies using the general population or economically active people as comparison groups reported an increased risk of between 19% and 30% in malignant as well as all neoplasms among male seafarers (12, 13, 25). A German study comparing seafarers with the general population reported 1.2-fold higher risk for malignant neoplasms at all sites (14). Studies on neoplasms among female seafarers are rare, but an increased risk, in line with our finding, has been reported but the estimate was not statistically significant (13), and another Danish study demonstrated an increased overall incidence of cancer of 14% for female seafarers compared with the
Amongst the most plausible explanations for higher risks for CVDs, neoplasms and respiratory diseases among seafarers than among farmers are work-specific occupational hazards and lifestyle factors. Many hazardous chemical substances, present as gases, vapours, dusts and fibres, to which seafarers are exposed are associated with increased risk for CVDs, neoplasms and respiratory diseases. Furthermore, shipboard stress, fatigue, long-time separation from the family, social isolation, reduced sleep quality and quantity and other psychosocial stressors may also impact seafarers’ health. Of permanent physical risk factors, noise is strongly associated with hypertension, whereas evidence on effects of ship movements and vibration as individual hazards for health outcomes is scarce or nonexistent.

Tobacco smoking is a strong lifestyle-related risk factor for many types of CVDs, cancer and respiratory diseases. Although data on seafarers’ smoking is rare, some evidence is available. Thus, two surveys from Denmark and France found that the prevalence of smoking among seafarers was 44% and 42%, respectively [28, 29], whereas the prevalence of daily smoking in the Danish general population was 32% [28]. The risk of being overweight among Danish male and female seafarers was 1.3 and 1.4 times higher than in the general population [30]. A recent study found that 40% of seafarers investigated on Italian-flagged ships were overweight, and more than 10% of them were obese [31]. Evidence on dietary intake among seafarers is almost nonexistent. However, a small-scale study among international seafarers recruited from German merchant ships found that the overall supply of meat, fat and eggs was more than double, whereas the proportions of fruits, vegetables, dairy products and cereals were much lower than recommended in the national guidelines [32]. While seldom accurately investigated, physical inactivity has been seen as a major problem in seafaring [8], and it is evident
that seafaring with shift work, unstructured work time, lack of training space and equipment on board may make regular physical activities challenging both on board and ashore.

**Strengths and limitations**

Our study benefits from a series of strengths, not at least the data based on registers of high quality with very little loss to follow-up and with two cohorts that improves reliability of the study and enables us to identify changes over time. However, our study is not without its limitations. First, we had no information about health behaviour which is a typical disadvantage in register-based health studies. Second, we had no information on hospital contacts or other health-related outcomes of participants prior to the beginning of the follow-up. It is, however, unlikely that this would have had a different effect on seafarers than on farmers and thereby affected the observed differences on incidence between the two occupational groups, and thus biased results. Third, seafarers’ access to health care is limited, particularly to the Danish land-based health care system. This may lead to an underestimation of hospital contacts among seafarers. In addition, we most probably underestimate the true difference between the two groups as we deliberately introduce a healthy worker effect through the regular health checks of the seafarers but not the farmers. Furthermore, the number of female seafarers was relatively low which affected power to identify associations. Lastly, the health outcomes used in this study were broad categories of diseases, and further studies are needed to address narrower categories of these outcomes, such as specific categories of neoplasms, particularly malignant neoplasms.

**Conclusions**

This is the first register-based study that compares the risk for CVDs, neoplasms and respiratory diseases among seafarers using another occupational group as a reference
group in order to reduce a potential healthy worker effect. This study demonstrates that male Danish seafarers have an increased risk for CVDs, neoplasms and respiratory diseases, female seafarers an increased risk for respiratory diseases and a reduced risk CVDs.

Abbreviations

CI: Confidence interval
COPD: Chronic obstructive pulmonary disease
CPR: Civil Personal Register
CVD: Cardiovascular disease
HR: Hazard ratio
NCD: Non-communicable disease
SD: Standard deviation

Declarations

Availability of data and materials

The data that support the findings of this study are available from The Danish Health Data Authority and Statistics Denmark but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available.

Data are however available from the authors upon reasonable request and with permission of The Danish Health Data Authority and Statistics Denmark.

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 Contributions

KH conceived and designed the study, interpreted the data, and drafted the initial manuscript. All authors were involved in the conception of this study, made critical revisions and approved the final manuscript.

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 Ethic declarations

Ethics approval and consent to participate

This study was approved by the Danish Data Protection Agency. In Denmark, it is not necessary to obtain ethical approval for the use of administrative register information in research, as long as the project does not involve human biological material.

 Consent for publication

Not applicable

 Competing interest

The authors declare that they have no competing interests.

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Figures

Figure 1
Age-adjusted incidence rates with accompanying 95% confidence intervals for hospital contacts from different causes among male farmers (green bar) and seafarers (blue bar) in the 2002 and 2012 cohorts.

Figure 2
Age-adjusted incidence rates with accompanying 95% confidence intervals for hospital contacts from different causes among female farmers (green bar) and seafarers (blue bar) in the 2002 and 2012 cohorts.