

# Association between nationality and occupational injury risk on Danish non-passenger merchant ships

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## ABSTRACT

**Background:** Maritime occupational accidents can be determined by several factors, among which human characteristics play a crucial role. Worker's safety behaviour depends on individual physical and mental characteristics as well as on his/her social and cultural background. The aim of this study is to investigate the frequency of workplace injuries in the Danish merchant fleet in the period 2010–2012, and to characterise its nationality dependence.

**Materials and methods:** Occupational injuries data reported from ships registered in the Danish International Ship Register to the Danish Maritime Authority were collected. Publicly available employment data were used to calculate the cumulative incidence rates for Danish, non-Danish European Union (EU) and non-EU employees working on non-passenger ships. Crude injury rates and rates adjusted for occupational status were statistically compared.

**Results:** The majority of accidents happened to Danish and non-EU workers on non-passenger ships. The injury rate varied around 70 per 1000 among Danish seafarers, while the rate for non-Danish employees was about 30 per 1000. Crude and adjusted relative risk was found significantly lower for EU (0.33–0.46; 0.26–0.39) and for non-EU (0.41–0.53; 0.54–0.65) workers compared to Danish seafarers. The difference decreased, but remained significant in most cases for serious injuries.

**Conclusions:** Occupational injury rates show considerable nationality differences as reported from non-passenger ships registered under the Danish flag. The differences can only be partly explained by varying reporting practices. The findings confirm the results of previous studies and point out the need for effective interventions in the high-risk groups.

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**Key words:** occupational accident, maritime safety, seafarers' nationality

## INTRODUCTION

Various workplaces in the maritime sector can be regarded as risky environments. Despite improvements, compared to other occupational settings, working on a ship can still be characterised with high rate of occupational accidents. In a large-scale international study, 9.1% of seafarers had self-reported injury during the last tour of duty and 4.3% had an injury with at least 1 day off work [1]. Seafarers working on British merchant ships had a 23.9 times higher risk of death due to occupational accident than all workers in average in Great Britain [2]. The relative risk of occupational mortality for a seafarer on board of Danish merchant ships was found

11.5 times higher compared to Danish male ashore workers in the period 1986–1993, and, in spite of the considerable improvement, the difference remained more than 6-fold in the period 2002–2009 [3, 4]. There are several factors that can contribute to the occurrence of a workplace accident, among which human factors play an important role [5]. Safety behaviour of an employee is determined by the individual physical and mental characteristics as well as social and cultural aspects.

Differences in occupational injury rates between employees with diverse nationality backgrounds have been indicated by previous studies. Workplace injuries have a higher incidence rate in developing countries in general [6],



but there are also considerable differences revealed by some studies between nationalities within the same country's workforce [7]. The occupational fatality rate was found higher among foreign workers and some minorities by several studies, but the differences for non-fatal injuries were less consistent. The nationality dependence of getting involved in an accident in the maritime workforce is an especially important question when taking into consideration the wide-scale representation of different nationalities among seafarers.

The present study aims to examine recent incidence rates of workplace injuries in the Danish merchant fleet reported in the period 2010–2012. The investigation focuses on analysing nationality dependence of getting involved in an accident and discussing possible explanations for the differences found.

## MATERIALS AND METHODS

The study used records of occupational accidents reported from ships registered in the Danish International Ship Register (DIS) to the Danish Maritime Authority as a source to collect data on maritime workplace injuries in the Danish fleet. Accidents occurring on board of ships registered in DIS are mandatory reported to the Danish Maritime Authority if they result in an injury causing at least 1 day off work beyond the day of accident (lost time accident – LTA), or making the injured person not being able to carry out his usual job for 1 day or more in addition to the day of the injury (restricted work accident – RWA). Besides the mandatory notified cases, milder injuries are also frequently reported to the authority. The study used reporting records from the period 2010–2012 and documented various characteristics of the injuries to form a comprehensive database. Altogether 1453 injured cases were identified during the 3-year study period. An injury was considered occupational in the study if it happened to the seafarer when he or she was on board at sea or in port, so events which happened onshore were excluded (28 cases). Injuries related to pirate attacks were also excluded from the analysis (22 cases). For the calculation of the cumulative incidence rate, a worker was considered a case if he or she had occupational injury during a year, therefore the second or third injuries that happened to the same person in the same year were not included in the analysis (37 cases).

The database contained information acquired from the notification records on personal identification, gender, nationality and position on board of the injured person, identification and type of ship where the accident happened, the date of accident, the conditions of the accident and the characteristics of the human injury. Ships were categorised as being passenger or non-passenger. Only accidents reported from the latter type were included in the detailed analysis. Employees were grouped by occupation as officer or non-officer. Navigation officers, including ma-

sters, and engineer officers, were considered as officers. Nationalities were allocated into 3 categories: Danish including employees from the Faeroe Islands and Greenland, non-Danish European Union (EU) citizens dominated by Central European Polish and Romanian seafarers, and non-EU employees among which Filipinos formed by far the largest group. There were 1353 injury cases that fulfilled the above described inclusion criteria and had information on the seafarer's nationality.

To calculate the cumulative incidence rates, publicly available employment data of DIS registered non-passenger ships were used. Data for 2010 and 2011 represent employment on September 30<sup>th</sup> of the given year, while for 2012 employment was available for the beginning of the year. The absolute number of employees was stratified by the above described 3 nationality categories, by officer or non-officer status and by passenger or non-passenger ship types.

The injury rates were calculated for all injuries and separately for serious injuries. The injury was considered serious if it was indicated as a LTA case on the notification record and/or if the reported incapacitation was at least 1 day beyond the day of accident.

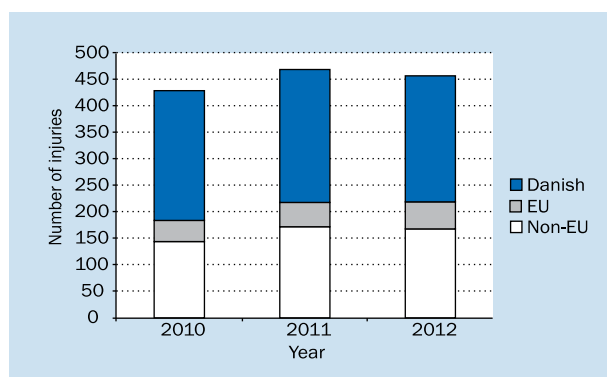
The relative risk was estimated by calculating the cumulative incidence rate ratios, taking the injury rate for Danish seafarers as the reference value. Differences between the incidence rates were statistically tested by the uncorrected  $\chi^2$  test. The adjustment to work type (officer vs. non-officer), as an important determinant of the occurrence of occupational injuries, was carried out by logistic regression.

## RESULTS

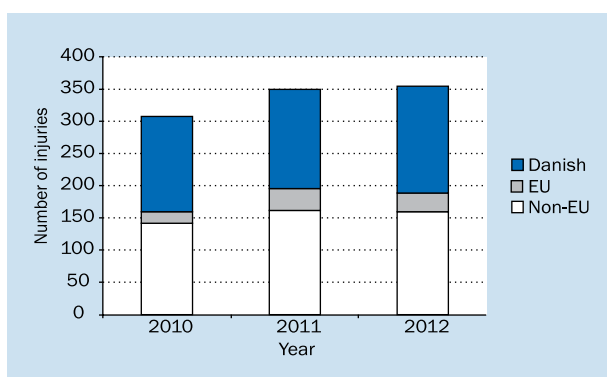
There were altogether 427 injuries reported in 2010, 469 in 2011 and 457 in 2012 from DIS registered ships to the Danish Maritime Authority. The majority of accidents happened to Danish and non-EU seafarers (Fig. 1).

Most of the accidents occurred on non-passenger ships (1013 out of 1353, 75%), the workforce of which includes a wide range of employees with different nationality background that creates a good opportunity for investigation. Therefore, to reveal nationality differences in the injury rates, accidents that took place only on non-passenger ships were further analysed. There were 308, 350 and 355 injuries reported from non-passenger ships in 2010, 2011 and 2012, respectively. The nationality distribution of injured cases is shown in Figure 2.

According to publicly available employment data, 6956, 8286 and 7289 positions were occupied on non-passenger ships registered in DIS in the examined years, respectively. The calculated cumulative incidence rate of occupational injuries can be regarded relatively stable over the investigated period, ranging between 40 and 50 injured per

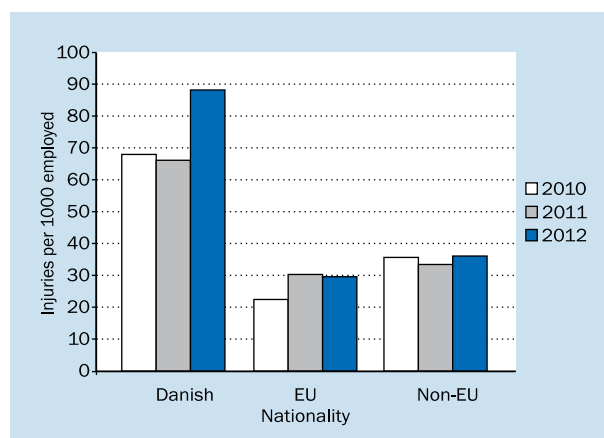


**Figure 1.** Number of occupational injuries occurring on board of all ships registered in the Danish International Ship Register



**Figure 2.** Number of occupational injuries occurring on board of non-passenger ships registered in the Danish International Ship Register

1000 employees (44.28, 42.24 and 48.70 per 1000 workers employed on DIS registered ships in 2010, 2011 and 2012, respectively). However, this overall incidence rate covers substantial differences experienced by employees coming from different countries. In each investigated year, the injury rate is markedly higher among Danish seafarers than among other EU or non-EU employees (Fig. 3). The injury rate varies around 70 per 1000 among Danish seamen, while for non-Danish workers the rate is about 30 per 1000. Considering the Danish incidence rate as the reference value, the crude estimate of the relative risk of getting injured is 0.33–0.46



**Figure 3.** Rate of occupational injuries by nationality of seafarers working on non-passenger ships registered in the Danish International Ship Register

for EU and 0.41–0.53 for non-EU seafarers (Table 1). All the estimates are significantly different from unity, inferring a statistically significant difference in injury rates in favour of EU and non-EU employees compared to the Danes.

The type of work determines the risk of getting injured, and since the distribution of job activities is not homogenous over nationality categories, e.g. South East Asian seafarers tend to take lower rank jobs than Danish and other Western European seafarers, this factor can function as a confounder. To rule out the confounding effect, estimates of relative risk adjusted for officer/non-officer status were calculated by logistic regression. Adjusted estimates of relative risk range 0.26–0.39 for EU and 0.54–0.65 for non-EU employees compared to Danes (Table 1). The significant nationality differences remain after adjustment.

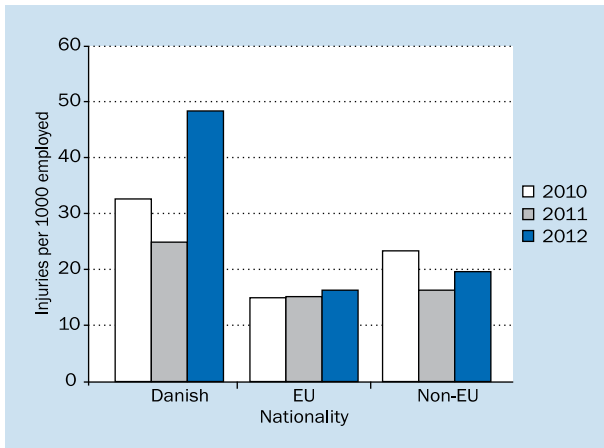
Similar analysis was performed taking into consideration only serious injuries that tend to be more likely reported. Approximately half of the injuries fall into the serious category (524 out of 1013, 52%). The difference between the injury rate of the Danish and other nationalities is still unequivocal, although somewhat smaller (Fig. 4).

According to the crude estimates, EU seafarers have significantly lower risk of getting seriously injured than the Danish, except for year 2011, when the difference is not

**Table 1.** Crude and adjusted estimates of relative risk of getting injured on board of non-passenger ships registered in the Danish International Ship Register. Nationality groups are compared to the Danish reference values

	Danish	EU		Non-EU	
		Crude*	Adjusted**	Crude*	Adjusted**
2010	1	0.330 (0.204–0.535)	0.266 (0.157–0.450)	0.525 (0.419–0.656)	0.654 (0.572–0.747)
2011	1	0.459 (0.317–0.660)	0.392 (0.266–0.580)	0.506 (0.408–0.627)	0.647 (0.570–0.734)
2012	1	0.336 (0.228–0.494)	0.256 (0.169–0.388)	0.409 (0.332–0.505)	0.536 (0.473–0.608)

\*Cumulative incidence rate ratio (95% confidence interval); \*\*Odds ratio (95% confidence interval), adjusted for job type as being officer or non-officer



**Figure 4.** Rate of serious occupational injuries by nationality of seafarers working on non-passenger ships registered in the Danish International Ship Register

significant, although still considerable (Table 2). Meanwhile, the risk of serious injury remains significantly lower among non-EU compared to Danish employees in each year. The adjusted estimates show exactly the same pattern. All differences in the serious injury rate are significant except that between Danish and EU nationalities in 2011.

The results indicate a weaker, but in most of the cases still statistically significant, difference in injury rates between nationality groups when considering only serious cases.

### DISCUSSION

The findings point out a stabilised accident rate reported from ships registered under the Danish flag in the investigated 2010–2012 period. The majority of injuries occur among Danish and non-EU seafarers that represent their largest share in the Danish maritime workforce. The risk of getting injured on board of a ship is, however, significantly different between nationality groups. Danes tend to get more frequently injured than their EU (mostly Central European) and non-EU (mostly Filipino) fellows. This finding is in accord with previous reports from Denmark. Hansen et al. [8] observed only half of the risk of Danish seafarers among their foreign colleagues to get injured on passenger and also on non-passengers ships, and the findings proved

to be significant after adjusting to various potential contributing factors. In a later study, the same author found significant differences in injury rates between Western and Eastern European as well as South East Asian employees, that remained significant after adjusting for ship size, job and age [9]. Eastern Europeans had an adjusted incidence rate ratio of 0.65, and South East Asians 0.29 compared to Western Europeans. The values increased to 0.82 and 0.36, respectively, when considering only serious cases, remaining the difference between Western European and South East Asian seafarers statistically significant. Another study in the maritime sector could also point out the lower risk of occupational injury among Filipino workers on a cruise ship where they comprised half of the crew, but contributed to 35% of the accidents only [10].

There can be various explanations for the observed nationality differences in the risk of occupational injury. It may be a real phenomenon caused by differences in safety behaviour and/or fitness to work. Differences in safety culture by nationality groups have been reported by previous studies [11]. However, the finding may also be artificial due to confounding effect or reporting bias.

The presented quantitative analysis attempted to rule out the possibility of confounding by the most important factor of occupational accidents – the job type. It is well known that injuries are more frequent among physical workers, that is, among non-officers in the maritime sector [1]. On Danish ships, Danes are more likely to take officer positions, while Eastern European and especially Asian workers often occupy lower rank jobs. In the regression analysis, the correlation of injury rates with nationality groups was adjusted for officer/non-officer job categories; still, the statistically significant differences remained, indicating that uneven distribution of job types does not explain the phenomenon.

Another possible reason for the observed low injury rate among non-EU seafarers is that they tend to report injuries less likely. Previous finding points out that accidents are systematically under-reported from some types of ships, like dry cargo ships, and by some crew nationalities, typically Filipinos and other foreign nationals [12]. An indirect way of exploring the influence of diverse reporting pattern in the actually reported injury rates is the analysis of serious

**Table 2.** Crude and adjusted estimates of relative risk of getting seriously injured on board of non-passenger ships registered in the Danish International Ship Register. Nationality groups are compared to the Danish reference values

	Danish	EU		Non-EU	
		Crude*	Adjusted**	Crude*	Adjusted**
2010	1	0.459 (0.250–0.842)	0.357 (0.182–0.700)	0.716 (0.528–0.971)	0.788 (0.660–0.939)
2011	1	0.609*** (0.356–1.04)	0.576*** (0.330–1.006)	0.655 (0.468–0.915)	0.713 (0.588–0.863)
2012	1	0.338 (0.200–0.571)	0.252 (0.144–0.441)	0.406 (0.304–0.542)	0.534 (0.452–0.630)

\*Cumulative incidence rate ratio (95% confidence interval); \*\*Odds ratio (95% confidence interval), adjusted for job type as being officer or non-officer; \*\*\*Not significant

injuries. The study considered the injury serious if the case was reported as LTA, although the difficulties of using the definition of this accident category (being off duty) at sea must be acknowledged. Serious injuries are more likely reported, since medical advice is required in several cases, so there is less opportunity to hide or neglect the event. The nationality differences in the rate of serious injuries proved to be less than the differences in total injury rates, although still remained significant in most relations and years. The findings indicate that reporting habits contribute to the observed differences, but do not explain them alone.

The study used the cumulative incidence rate to explain the risk of getting injured, which is a crude measure of risk. The number of employees change permanently over time, so employment data on a specific date does not necessarily reflect the average situation during the year. A seafarer may spend various length of time aboard and a longer time at risk implies higher chance of getting injured, a factor that could not be taken into consideration in this study. However, if the time at risk is homogenously distributed over nationality categories, this shortage does not introduce bias.

## CONCLUSIONS

In conclusion, there are substantial differences between nationalities in occupational injury rates, as reported from non-passenger ships operating under the Danish flag. The results indicate that the phenomenon described first in the 1990s is still characteristic in recent years. The significantly higher rate among Danish seafarers is only partially explained by potential differences in reporting, so the reason behind likely includes differences in safety behaviour. The driving forces to behave in a safe way are suggested by previous reports (unpublished data); however, further studies are needed to explore the societal and human factors contributing to workplace safety and thereby allow for planning effective interventions, aiming at lowering the risk in those target work populations, that can still be characterised with excessive occupational injury rate.

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