Fatigue and health in a seafaring population

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Background Occupational fatigue is relatively common within the general population and has been linked to reduced performance, injury and longer term ill-health. Despite growing acknowledgement of this problem in the maritime sector, little research has been conducted into the risk factors, prevalence and consequences of seafarers’ fatigue.

Aims To examine the prevalence of fatigue among seafarers, identify potential risk factors and assess possible links with poor performance and ill-health.

Methods Cross-sectional questionnaire survey of seafarers working in the offshore oil support, short-sea and deep-sea shipping industries. A number of tools were used including the fatigue subscale of the profile of fatigue-related symptoms, the Cognitive Failures Questionnaire, the General Health Questionnaire and the SF36 General Health scale.

Results In all, 1855 questionnaires were completed giving an overall response rate of 20%. Fatigue symptoms were associated with a range of occupational and environmental factors, many unique to seafaring. Reporting a greater number of risk factors was associated with greater fatigue [e.g. OR = 2.53 (1.90–3.35) for those with three or four risk factors and OR = 9.54 (6.95–13.09) for those with five or more risk factors]. There was also a strong link between fatigue and poorer cognitive and health outcomes, with fatigue the most important of a number of risk factors, accounting for 10–14% of the variance.

Conclusions Seafarers’ fatigue could impact on safety within the industry and may be linked to longer term individual ill-health. It can only be addressed by considering how multiple factors combine to contribute to fatigue.

Key words Fatigue; seafarers; shipping; sleep; tiredness; work.

Introduction

Fatigue is an everyday experience common among the general working population, with prevalence estimates as high as 22% [1]. Although difficult to define, it is generally thought of as a subjective sensation on a continuum [2] with behavioural, emotional and cognitive components [3]. It has been associated with accidents, injuries [4], reduced performance [3,5] and ill-health [6,7]. A considerable body of research has, therefore, focused on identifying work schedules and psychosocial work characteristics associated with fatigue and links between fatigue and ill-health.

Working at sea certainly has the potential to be fatiguing [8], and the shipping industry is increasingly concerned about its possible effect on personal and operational safety. Despite guidance on fatigue management [9] and amendments to working time regulations, recent research among seafarers showed that almost 50% felt their hours had increased and that this compromised health and safety [10].

Seafarers are as likely as other workers to be exposed to work schedules and characteristics associated with fatigue. They are also, however, subject to industry-specific factors potentially linked to fatigue. For example, fast port turnarounds and harsh environmental conditions, with demanding (often split) shift systems, regular sustained attention and physical exertion, have been associated with interrupted sleep and fatigue [11,12]. Furthermore, numerous anecdotal reports and limited empirical evidence cite fatigue as a causal factor in accidents [13] and impaired collision risk awareness [14]. The impact of long periods of sustained attention and inadequate rest has been documented in other transport sectors [15,16]. However, no systematic attempt to determine levels of fatigue at sea, and associated risk factors, has previously been made.

The concept of a process from negative work conditions, to fatigue, to poor performance in the short-term...
and longer term ill-health [7,17] has been suggested. Prospective studies have shown that psychosocial work characteristics significantly predict fatigue onset [17] and that preceding fatigue is significantly related to illness [7]. Although the direction of the relationship between risk factors for fatigue and ill-health has not been conclusively established, the concept of fatigue in this context merits investigation.

This paper first considers associations between negative occupational factors and perceived fatigue to establish a profile of risk factors associated with fatigue among seafarers working in the UK merchant shipping industry. It goes on to assess any association between fatigue and poorer health, well-being and cognitive performance. Two aspects of perceived fatigue have been measured: acute fatigue (fatigue at and immediately after work and symptoms of fatigue at work) and longer term fatigue (fatigue in the past week). We expected that (i) work schedules would be most strongly linked to acute and psychosocial work characteristics with longer term fatigue and (ii) longer term fatigue would be associated with poorer perceived cognitive performance and health and well-being. Within this framework, seafaring-specific and more general factors were considered. The combined effects of identified risk factors were also considered. Factors associated with fatigue are not experienced in isolation, and this combined effects approach, where the simple number of factors experienced is calculated, may be a more appropriate way of considering ‘real-world’ associations with work-related fatigue.

Establishing a profile of factors associated with fatigue among seafarers could inform ways of tackling fatigue at sea, thus improving safety in this sector as well as longer term individual health.

**Methods**

British merchant shipping industry seafarers took part in a questionnaire survey collecting cross-sectional data as part of a wider project assessing fatigue, health and injury [12]. The project comprised three phases each covering a separate industry sector: (i) offshore support (surveyed 2000–01), (ii) short sea and coastal (2002–03) and (iii) deep sea (2004–05). Questionnaires were distributed as part of each phase through three channels: unions, shipping companies and on-board research. Early experience during the wider project suggested that seafarers were a particularly difficult group to survey comprehensively, so this pragmatic approach to questionnaire distribution was taken to maximize sample coverage and diversity. Overall 9438 questionnaires were distributed across the three phases as described in Appendix 1, Table A1 (available as Supplementary data at *Occupational Medicine* Online).

Ethical approval was granted by the Cardiff University School of Psychology Ethics Committee.

Four scales were used to measure acute and longer term perceived fatigue (as described in Appendix 1, Table A2, available as Supplementary data at *Occupational Medicine* Online):

- Longer term fatigue (in the last week)
  - The fatigue subscale of the profile of fatigue-related symptoms (PFRS-f) [18]
- Acute fatigue (at or immediately after work)
  - Fatigue at work [19,20]
  - Fatigue after work [19,20]
  - Symptoms of fatigue at sea [21]

The fatigue outcome measures have been validated elsewhere [12].

One measure of perceived performance and two of perceived well-being and health were used (as described in Appendix 1, Table A2, available as Supplementary data at *Occupational Medicine* Online):

- Cognitive Failures Questionnaire [22]
- General Health Questionnaire [23]
- SF36 General Health scale [24] (measured using a personal evaluation of health including current health, health outlook and resistance to illness).

In addition to occupational and demographic measures (Appendix 1, Table A2, available as Supplementary data at *Occupational Medicine* Online), composite variables were derived to represent key organizational and environmental stressors (based on four-factor analyses: see Appendix 2, Table A5, available as Supplementary data at *Occupational Medicine* Online). These were sleep quality, sleep disturbance, physical hazards, environmental factors, variable working hours, job demands, support at work and job security. A full list of individual items and original scoring is provided in Appendix 3, Table A6 available as Supplementary data at *Occupational Medicine* Online.

Analyses were carried out using SPSS (version 12.0.2) to assess associations between:

1. fatigue and organizational schedules
2. fatigue and psychosocial work characteristics
3. fatigue and job and demographic characteristics
4. fatigue and cognitive performance and health and well-being.

To consider factors common to all workers separately from those specific to seafaring, forward stepwise regression analyses were carried out in blocks (entry *P* < 0.05). The first block included organizational schedule and work characteristics common to all workers (organizational schedules: hours worked per day, shift schedule and variable working hours; psychosocial work characteristics: work stress, job security, job demands, support at work and physical hazards). The second block included organizational, psychosocial work and job characteristics.
specific to seafaring [organizational schedules: tour length, sleep quality and sleep disturbance; psychosocial work characteristics: environmental factors, switching to port work (i.e. changing from vessel work at sea to vessel work in port) and port frequency; job characteristics: department and flag]. The final block included demographic characteristics common to all (marital status, education, age and current smoker). Significant variables from each block were retained in the following block. Next, analyses were carried out to consider the combined effect of the factors associated with fatigue. To be comparable with previous combined effects analyses [25], logistic regression analyses were used. The outcome variables were dichotomized at the median and a negative occupational factors (NOF) score calculated indicating how many of the factors associated with each outcome (identified using the regression analyses described above) each respondent reported.

Two further sets of multivariate regression analyses were carried out:

(i) including the factors associated with longer term (PFRS) fatigue identified using the analyses described above and

(ii) including the significant factors from (i) at Block 1 and these same factors together with longer term (PFRS) fatigue at Block 2.

This allowed the identification of longer term fatigue risk factors that were also associated with the health outcomes in order to determine any independent association between ill-health and longer term fatigue over and above that of other risk factors associated with ill-health.

Results

In total, 1855 questionnaires were completed, 563 from offshore support workers, 936 from short sea and coastal workers and 356 from deep sea workers. Response rates for the three sectors were 31, 23 and 10%, respectively, and overall 20% of all those approached (Appendix 1, Table A1, available as Supplementary data at Occupational Medicine Online).

Ninety-six per cent of respondents were male (n = 1780) with a mean age of 43.5 years (median 45, range 17–66). The majority (n = 1413, 76%) were married or cohabiting and 92% (n = 1704) described themselves as British. On average, they had worked for 23.1 years (median 25, range 1–48) at sea. Most (n = 1546, 83%) were deck or engineering officers, as opposed to ratings, catering, service or other personnel. Most reported working >28 days (n = 699, 38%) or 15–28 days on (n = 531, 29%), and the most commonly reported shift schedules were 12 h (n = 565, 30%) or 6 h on (n = 325, 18%). Most respondents worked 8–12 h/day (n = 1048, 56%). Table 1, in which each column represents a regression model, summarizes the associations between fatigue and work characteristics and indicates in italics which factors are specific to seafaring. High work stress, job demand, shorter tour length and poor sleep quality were associated with both acute fatigue (across all three measures) and longer term fatigue. Younger age, lack of support, physical hazards, sleep disturbance and smoking were all also associated with both acute fatigue (at least one measure) and longer term fatigue. Environmental factors, finding switching to port work fatiguing, longer time on shift, poorer job security, variable work hours and working >12 h/day were associated only with acute fatigue, while department (other than deck or engineering) was associated only with longer term fatigue. Table 1 also shows that organizational schedules and psychosocial work characteristics common to all workers (Block 1) accounted for between 18 and 30% of the variance. Repeating the analyses with factors specific to seafaring (Block 2) first (data not shown) showed that the seafaring-specific factors accounted for between 15 and 23% of the variance.

The results of the combined effects analyses are shown in Table 2. For each outcome, there are significantly higher odds ratios with greater numbers of negative occupational factors indicating that respondents reporting more negative occupational factors were significantly more likely to report both perceived acute and longer term fatigue.

Finally, the results of the analyses focused on the three health outcomes are summarized in Table 3. First, models established which of the longer term fatigue risk factors (i.e. PFRS fatigue risk factors—shown in Table 1) were associated with each of the health outcome measures. These are shown in non-bold type. Next, these associated factors were included in further analyses, with longer term (PFRS) fatigue also included at Block 2. These results are in bold type. The pattern of associations between the two sets of analyses was very similar, suggesting that including fatigue did not explain the associations between the health outcomes and the longer term fatigue risk factors. However, longer term fatigue was also strongly associated with each outcome and had a greater impact than any other single variable. It accounted for 14% of the variance in cognitive failures (over a third as much as all the other variables together), 10% in psychological distress (a third as much as the other variables) and 12% in general health (half as much as the other variables).

Discussion

Four factors were consistently associated with both acute and longer term fatigue across all four outcome measures: work stress, job demand, sleep quality and tour length (shorter tours). The 16 variables associated with at least one fatigue outcome crossed all work-related
dimensions, including factors common to all workers and those specific to seafaring. More organizational schedule factors were associated with acute fatigue and more psychosocial work characteristics were associated with longer term fatigue. These findings depend in part on the way in which the data are analysed. However, the analyses have been carried out in several different ways and the main findings remain the same with both general and seafarer-specific factors showing consistent association with perceived fatigue.
An overall NOF score was calculated as the total number of risk factors present in a participant’s working life. There was a dose–response association between the number of risk factors and each of the fatigue outcome measures, supporting the use of a combined effects approach. A strong, independent association between longer term fatigue and the three health outcome measures was also found. Furthermore, longer term fatigue was more important than any other single risk factor, accounting for between a third and half as much of the variance as all the other factors together. This shows an independent association that is significant over and above other associations in combination, suggesting that perceived fatigue is an important and potentially influential factor.

When assessing fatigue, both consequential occupational and longer term individual impacts must be considered. If an officer falls asleep on watch, collisions or groundings can occur, cargo can be destroyed, coastlines

<table>
<thead>
<tr>
<th>Longer term fatigue</th>
<th>Cognitive Failures Questionnaire, $P$</th>
<th>General Health Questionnaire, $P$</th>
<th>SF-36 General Health, $P$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Models excluding fatigue</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Models including fatigue</td>
<td>$&lt;0.001$</td>
<td>$&lt;0.001$</td>
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</tbody>
</table>

**Sleep quality**

| Models excluding fatigue | $<0.001$ | $<0.001$ | $<0.001$ |
| Models including fatigue | $<0.001$ | $<0.001$ | $<0.001$ |

**Job demand**

| Models excluding fatigue | $<0.001$ | $<0.001$ | $<0.001$ |
| Models including fatigue | $<0.001$ | $<0.001$ | $<0.001$ |

**High work stress**

| Models excluding fatigue | $<0.01$ | $<0.01$ | $<0.01$ |
| Models including fatigue | $<0.001$ | $<0.001$ | $<0.001$ |

**Tour length**

| Up to 7 days | Models excluding fatigue | $<0.001$ | $<0.001$ |
| Models including fatigue | $<0.001$ | $<0.001$ | $<0.001$ |

| 8–14 days | Models excluding fatigue | $<0.001$ | $<0.001$ |
| Models including fatigue | $<0.001$ | $<0.001$ | $<0.001$ |

| 15–28 days | Models excluding fatigue | $<0.001$ | $<0.001$ |
| Models including fatigue | $<0.001$ | $<0.001$ | $<0.001$ |

**Age**

| Models excluding fatigue | $<0.001$ | $<0.001$ |
| Models including fatigue | $<0.001$ | $<0.001$ |

**Sleep disturbance**

| Models excluding fatigue | $<0.001$ | $<0.001$ |
| Models including fatigue | $<0.05$ | $<0.05$ |

**Physical hazards**

| Models excluding fatigue | $<0.001$ | $<0.001$ |
| Models including fatigue | $<0.001$ | $<0.001$ |

**Support**

| Models excluding fatigue | $<0.001$ | $<0.001$ |
| Models including fatigue | $<0.001$ | $<0.001$ |

**Current smoker**

| Models excluding fatigue | $<0.001$ | $<0.001$ |
| Models including fatigue | $<0.001$ | $<0.001$ |

**Department (other)**

| Models excluding fatigue | $<0.01$ | $<0.01$ |
| Models including fatigue | $<0.001$ | $<0.001$ |

| Step, $R^2$, $\Delta R^2$, $P$ | 9, 0.22, 0.004, 0.005 | 5, 0.19, 0.003, 0.03 | 6, 0.12, 0.004, 0.01 |
| Step, $R^2$, $\Delta R^2$, $P$ | 2, 0.36, 0.14, $<0.001$ | 2, 0.30, 0.10, $<0.001$ | 2, 0.24, 0.12, $<0.001$ |

Full details are shown in Appendix 1, Table A4 (available as Supplementary data at *Occupational Medicine* Online). Factors specific to seafaring shown in italics. NA = not applicable.

*Forward stepwise regression models showing: (i) significant factors from the final step of models assessing the factors associated with each outcome—in ordinary type.
(ii) significant factors from the second step, in which fatigue was entered into the model, of models assessing the association between fatigue and each outcome independent of the other factors identified in models (i)—in bold type.*
polluted and lives lost. Consequences on this scale are unlikely to face an onshore worker.

This study is the first to include seafarers from all sectors of the British seafaring industry, and, within this group, to consider multiple factors, their association with fatigue both individually and in combination and the relationship between fatigue and ill-health. There remain, however, a number of methodological and sampling-related problems. First, the cross-sectional design did not permit causal inferences. Second, confounded variables made it difficult to assess the relative impact of different factors (e.g., only ferries visit ports multiple times a day, so the impact of vessel type independent of port-visit frequency could not be determined). Third, all data were obtained using self-report questionnaires giving subjective and common instrument bias. Fourth, the data were collected over several years while changes in the industry have taken place (e.g., the introduction of the International Ship and Port Facility Security Code which places increased emphasis on security). In addition, most of the sample was British (>90%) and most were officers (>80%). The response rate was relatively low, and the questionnaire distribution methods diverse, limiting the study’s generalizability. However, surveying this diverse group is particularly difficult, so a pragmatic approach to sampling and questionnaire distribution was taken. This resulted in questionnaires being distributed to ~39% of the estimated number of UK seafarers (24 500; figure taken from Nautilus UK Web site). Finally, seafarers must pass a medical examination before joining the industry and must continue to pass medicals to remain in employment. This group, therefore, is likely to show a strong ‘healthy worker effect’ [26].

The findings reported here provide support for previous assertions linking occupational fatigue with excessive working hours, environmental hazards and high job demands [17,20,27]. They also add weight to the argument that exposure to workplace stressors is cumulatively associated with a negative outcome [25]. Fatigue levels and associated risk factors were comparable with those of large onshore studies [1]. However, factors unique to seafarers were also influential suggesting that interventions should be tailored to this group, with issues surrounding port turnarounds, crewing arrangements and legislative enforcement requiring more attention.

The direction of the relationships between work characteristics, fatigue and ill-health are not clear, and they may not be one way: fatigue is a common symptom of illness and may result in more negative interpretation and/or coping with work characteristics; or negative work characteristics may lead to fatigue which may result in poor health and well-being. The latter has been suggested elsewhere in a study of the general working population [7], which found that as fatigue decreased from a period of high fatigue, so the incidence of infections decreased. In that study, the reasons for a change in fatigue were not investigated, though the authors suggest changes in work-related or personal factors [7]. It is also possible that the findings reflect something other than relationships between work characteristics, fatigue and poorer health: they may, for example, stem from a particular personality trait. Further longitudinal research is required to clarify the direction and strength of these relationships. Given the evidence implicating fatigue as a causal factor in accidents and impaired awareness of collision risk [14,16,28] and linking fatigue to longer term personal consequences such as ill-health among general workers [7] and here among seafarers, aspects of the working environment which may create fatigue should be given greater priority.

Investigating seafarers’ fatigue requires the understanding and exploration of a number of factors. Each seafarer’s working context is defined by multiple factors, many unique to sea. Approaches to managing seafarers’ fatigue therefore need to be flexible enough to represent individual circumstances. This study suggests that a combined effects technique shows promise in this regard and may be a good way of assessing and predicting seafarer fatigue.

**Key points**

- Work stress, job demands, sleep quality and short tours of duty were associated with fatigue.
- Fatigue should be addressed by considering how multiple factors combine to cause fatigue.
- Fatigue among seafarers may also have longer term health consequences.

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**Conflicts of interest**

None declared.

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