Work-related musculoskeletal disorders in Norway’s offshore petroleum industry

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Introduction

Musculoskeletal disorders are important diagnostic causes of sick leave and disability pensioning among Norway’s petroleum workers offshore [1] as well as onshore [2]. Epidemiological studies have shown associations between work-related risk factors such as manual material handling, heavy physical load, repetitive movements, psychosocial factors and musculoskeletal disorders [3]. Several offshore occupational groups working in production, drilling operations, maintenance and catering are exposed to some of these well-known risk factors [4]. Nevertheless, few studies have been published on offshore oil installation workers and musculoskeletal disorders [1,5]. Offshore work differs from most onshore work, as all personnel work 12-h shifts for 14 days and then have 4 weeks off.

Since 1992, the petroleum industry has reported work-related diseases to the Norwegian Petroleum Safety Authority. The workers in the offshore companies are examined by a physician every 1 or 2 years due to requirement of a health certificate. This task has until quite recently been performed by an occupational physician but other physicians will probably have this task in the future. Physicians are required by law to report all suspected work-related diseases among workers on Norway’s continental shelf. An important purpose of reporting is to get information about unhealthy workplaces in order to improve working conditions. The annual reports of the Petroleum Safety Authority have included overviews of work-related diseases among offshore workers, but work-related musculoskeletal disorders have not been analysed in detail.

This study analysed the number of work-related musculoskeletal disorders and their risk factors (occupation...
and reported type of exposure) reported to the Petroleum Safety Authority from 1992 to 2003. The results may be useful for planning future efforts to prevent work-related musculoskeletal disorders offshore.

Methods

We analysed data from the Petroleum Safety Authority’s registry of work-related diseases offshore from 1992 to 2003. The registry is based on information from an official registration form to be completed by physicians in Norway reporting new cases of disease presumed to be caused by work or in which work has contributed to the disease. Long-term musculoskeletal disorders are to be reported only once unless the disorder recurs after the person has been free from it for at least 1 year. Types of work exposure assessed as potentially related to the disease are also to be reported. The registration forms are sent to the Petroleum Safety Authority for offshore workers and to the Norwegian Labour Inspection Authority for onshore workers.

The Petroleum Safety Authority’s registry includes information about the worker’s diagnosis, age, occupational category and occupation and description of types of exposure that might be causally linked. There is no information on the sex of the workers. The diagnoses were coded by the Petroleum Safety Authority according to the ninth revision of the International Classification of Diseases. The classification of occupational categories and occupations was designed especially for this registry. The five occupational categories are drilling, maintenance, catering, maritime occupations and administration/product. Drilling is subdivided into 23 different occupations, such as roughnecks and drilling operators. The maintenance category has 35 occupations, including electricians, painters and mechanics. The catering category includes six occupations, such as cleaning personnel (catering assistants), cooks and bakers. Among the seven occupations in the maritime category are ships’ engineers and telecommunication operators. Examples of the 19 different titles in the administration and production category are process technician, deck crew and crane operator as well as engineers and managers. The information about occupation is based on the occupation at the time of reporting the disease. Previous occupation was not included in the analyses, as such information was not available for most of the cases.

This article focuses on work-related musculoskeletal disorders, but the registry also contains information about other diagnoses. Employment data from the Petroleum Safety Authority on annual hours of work were used to calculate the rates (cases per million hours of work). Rates for each occupation or occupational category were not calculated, as appropriate employment data at this level were not provided.

Percentages were calculated for reported cases of work-related musculoskeletal disorders from 1992 to 2003 according to year of reporting, anatomical region, occupation and work exposure. The Pearson $\chi^2$ test was used to compare occupational categories (maintenance, production, drilling, catering) regarding musculoskeletal disorders from different anatomical regions (head, neck, back, upper limb, lower limb) and exposure (high physical workload, repetitive work, walking/climbing stairs, fixed positions, unexpected movements, kneeling). Analysis of variance (ANOVA) was used to assess the difference in mean age between years of reporting. All analyses were performed using SPSS 13.0 for Windows.

Results

During the 12-year period 1992–2003, 6725 cases of work-related diseases were reported to the Petroleum Safety Authority in Norway. Among these were 3131 new cases of musculoskeletal disorders. Occupational physicians reported 92%, general practitioners 2% and other physicians 5%. Work-related musculoskeletal disorders accounted for 47% of all diseases reported and was the most frequent work-related disease category every year except 1993 and 2003. The other large disease groups were hearing loss (25%) and skin diseases (15%).

Relatively few cases of work-related musculoskeletal disorders and other work-related diseases were reported before 1995. From 1995, an average of 319 cases of work-related musculoskeletal disorders were reported annually. The number varied substantially from year to year and decreased from 15 per million working hours in 1998 to 7 per million working hours in 2003 (Figure 1). The other diagnostic groups varied similarly. The mean age of workers with work-related musculoskeletal disorders increased from 35 years (SD 8) in 1992 to 45 years (SD 10) in 2003 (one-way ANOVA, $P < 0.001$). The corresponding mean ages for all other work-related diseases were 40 (SD 10) and 46 (SD 9), respectively.

![Figure 1. Work-related musculoskeletal disorders (WMSD) reported to the Petroleum Safety Authority in Norway, 1992–2003: number of cases and cases per million hours of work ($n = 3131$).](https://academic.oup.com/occmed/article-abstract/57/2/112/1583169)
Disorders of the upper limbs accounted for 53% of all cases (Table 1), back pain 20% and neck disorders 8%. Disorders of the lower limbs accounted for 16%, and knee disorders dominated among these (12% of all cases). About 40% of all reported cases were maintenance workers. Mechanics, electricians and scaffolders were the dominant occupations in this occupational category. Catering workers accounted for 21% of all cases, with catering assistants as the dominant occupation. In the drilling category (13%), the dominant occupation was roughneck, and the administration/production category (17%) included process technicians, deck crew and crane operators. In the maritime occupational category, only 25 cases (1% of the total number of cases) were reported in the whole period. The proportion of cases with regard to anatomical regions (upper limb, lower limb, back and neck) within the four main occupational categories differed significantly between the groups ($\chi^2$, $P < 0.001$, df = 12).

The types of exposures most frequently reported as the cause of work-related musculoskeletal disorders were high physical workload (38%) and repetitive work (26%) (Table 2). The proportion of exposures within the four main occupational categories differed significantly between the groups ($\chi^2$, $P < 0.001$, df = 18). A total of 67% of the scaffolders and 52% of the roughnecks with musculoskeletal disorders reported high physical load as the exposure independent of anatomical regions. Walking on hard surfaces/climbing stairs or ladders was reported as the cause in 10% of the cases, primarily among workers with lower limb disorders, and was most frequently reported among workers in administration/production (18%). Repetitive work was a frequently reported exposure in the catering category (43%). In only 1% of the cases were high job demands reported as the cause (not shown in the table). The type of exposures reported as the cause of the work-related musculoskeletal disorders varied little between years.

### Discussion

Work-related musculoskeletal disorders accounted for nearly half of the reported cases of work-related diseases in Norway’s offshore oil industry from 1992 to 2003. Workers in maintenance represented the largest group of cases, upper limb and back were the most frequently reported anatomical regions and high physical workload and repetitive work dominated as the reported causes. The relatively high proportion of musculoskeletal disorders has also been found in Denmark’s offshore oil industry [6] and in the UK [7,8].

Work-related musculoskeletal disorders also comprise the main reason for work-related consultations in general practice [9,10]. However, work-related musculoskeletal disorders accounted for a much lower proportion of reported work-related diseases among onshore workers in Norway: only 10–15% of the cases reported to the Norwegian Labour Inspection Authority [11]. One explanation for the difference between onshore and offshore workers might be the Petroleum Safety Authority’s focus on reporting work-related disease, especially work-related musculoskeletal disorders. Secondly, only a small fraction of work-related diseases are reported to the Norwegian Labour Inspection Authority, and the underreporting is supposed to be greatest for diseases that do not entitle workers to workers’ compensation benefits in Norway, such as most work-related musculoskeletal disorders [11].

Thirdly, in

### Table 1. Numbers of work-related musculoskeletal disorders reported from 1992 to 2003 to the Norwegian Petroleum Safety Authority by anatomical region (among all cases, in the four main occupational categories and in the 11 main occupations)

<table>
<thead>
<tr>
<th>Occupational category and occupation</th>
<th>Upper limb (%)</th>
<th>Lower limb (%)</th>
<th>Back (%)</th>
<th>Neck (%)</th>
<th>Other (%)</th>
<th>Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All cases</td>
<td>1602 (53)</td>
<td>493 (16)</td>
<td>601 (20)</td>
<td>237 (8)</td>
<td>84 (3)</td>
<td>3017 (100)</td>
</tr>
<tr>
<td>Maintenance</td>
<td>614 (51)</td>
<td>247 (21)</td>
<td>227 (19)</td>
<td>76 (6)</td>
<td>31 (3)</td>
<td>1195 (100)</td>
</tr>
<tr>
<td>Mechanics</td>
<td>119 (48)</td>
<td>52 (21)</td>
<td>53 (21)</td>
<td>16 (6)</td>
<td>9 (4)</td>
<td>249 (100)</td>
</tr>
<tr>
<td>Electricians</td>
<td>75 (41)</td>
<td>54 (30)</td>
<td>30 (16)</td>
<td>19 (10)</td>
<td>6 (3)</td>
<td>183 (100)</td>
</tr>
<tr>
<td>Scaffolders</td>
<td>84 (54)</td>
<td>28 (18)</td>
<td>30 (19)</td>
<td>10 (6)</td>
<td>5 (3)</td>
<td>157 (100)</td>
</tr>
<tr>
<td>Painters</td>
<td>57 (52)</td>
<td>22 (20)</td>
<td>22 (20)</td>
<td>7 (6)</td>
<td>2 (2)</td>
<td>110 (100)</td>
</tr>
<tr>
<td>Welders</td>
<td>74 (55)</td>
<td>29 (22)</td>
<td>23 (17)</td>
<td>4 (3)</td>
<td>4 (3)</td>
<td>134 (100)</td>
</tr>
<tr>
<td>Catering</td>
<td>404 (64)</td>
<td>34 (5)</td>
<td>106 (17)</td>
<td>68 (11)</td>
<td>21 (3)</td>
<td>633 (100)</td>
</tr>
<tr>
<td>Catering assistants</td>
<td>329 (62)</td>
<td>25 (5)</td>
<td>86 (16)</td>
<td>51 (10)</td>
<td>37 (7)</td>
<td>528 (100)</td>
</tr>
<tr>
<td>Cooks</td>
<td>60 (58)</td>
<td>8 (8)</td>
<td>21 (20)</td>
<td>11 (11)</td>
<td>4 (4)</td>
<td>104 (100)</td>
</tr>
<tr>
<td>Drilling</td>
<td>194 (50)</td>
<td>55 (14)</td>
<td>117 (29)</td>
<td>20 (5)</td>
<td>6 (2)</td>
<td>392 (100)</td>
</tr>
<tr>
<td>Roughnecks</td>
<td>88 (40)</td>
<td>32 (15)</td>
<td>82 (37)</td>
<td>7 (3)</td>
<td>10 (5)</td>
<td>219 (100)</td>
</tr>
<tr>
<td>Administration and production</td>
<td>252 (47)</td>
<td>120 (22)</td>
<td>105 (19)</td>
<td>46 (9)</td>
<td>17 (3)</td>
<td>540 (100)</td>
</tr>
<tr>
<td>Process technicians</td>
<td>70 (43)</td>
<td>52 (32)</td>
<td>24 (15)</td>
<td>13 (8)</td>
<td>3 (2)</td>
<td>162 (100)</td>
</tr>
<tr>
<td>Deck crew</td>
<td>58 (45)</td>
<td>22 (17)</td>
<td>39 (30)</td>
<td>6 (5)</td>
<td>4 (3)</td>
<td>129 (100)</td>
</tr>
<tr>
<td>Crane operators</td>
<td>56 (50)</td>
<td>20 (18)</td>
<td>20 (18)</td>
<td>10 (9)</td>
<td>5 (5)</td>
<td>111 (100)</td>
</tr>
</tbody>
</table>

All cases: $N = 3050$, four main occupational categories: $n = 2871$, the 11 main occupations: $n = 2086$. Missing data are not shown.
contrast to onshore companies, Norwegian legislation requires all offshore companies to have occupational health services. This provides opportunities to research work-related diseases among offshore workers. In general, the problem of differentiating between work-related musculoskeletal disorders and disorders related to other causes may result in underreporting. Lack of recognition is especially likely for diseases with long latency periods, symptoms common to non-occupational disorders or diseases with multiple causal factors [12].

Psychosocial factors (described as high job demands) were reported as exposure in only 1% of the work-related musculoskeletal disorders. Based on the known association between psychosocial factors and musculoskeletal disorders [13], this proportion was expected to be higher. One explanation might be the difficulty in concluding that musculoskeletal disorders are related to psychosocial factors at work compared with physical risk factors at work, especially in occupations where physical risk factors are obvious.

The reason why very few cases of work-related musculoskeletal disorders were reported before 1995 is probably because the registry was being developed, as other diagnoses had low numbers in this period. The variation in the number of reported work-related musculoskeletal disorders from year to year may be caused by different reporting practices between companies and variation in reporting within the same company [14]. The companies may differ because they define work-related disease differently [19]. The variation within a company possibly reflects periods of special focus on work-related musculoskeletal disorders or an all-out effort in reporting. This phenomenon entails a low potential to follow trends in the incidence of diseases. Evaluating trends requires an improvement of the reporting routines.

The mean age among workers with new cases of work-related musculoskeletal disorders increased in the study period, as did the mean age among cases with other work-related diseases. This seems to reflect the general ageing of offshore workers in the same period [14].

Most of the work-related musculoskeletal disorders were located in the upper limbs and back, which is in accordance with a study on reporting work-related musculoskeletal disorders in the UK [16] and a review study of work-related diseases in general practice [9]. Upper limb disorders and back disorders are also the most common self-reported musculoskeletal disorders in the general population [17,18], in the offshore industry [19] and in other industries [20], irrespective of whether the disorders are related to work. However, Norway's offshore industry seems to have more lower limb disorders (16%) than the Musculoskeletal Occupational Surveillance Scheme (MOSS) registry (7%) [16]. Occupational health personnel in the offshore industry have been discussing extensive walking on hard surfaces and climbing ladders or stairs as possible risk factors for knee disorders. A few studies have found a relationship between climbing stairs and knee disorders [21–23], but only one study related knee disorders to extensive walking [22]. A case–control study in Hong Kong found that subjects climbing stairs had a higher risk of developing osteoarthritis of both hips and knees [21]. A nested case–control study among patients undergoing meniscectomy found an increased risk of meniscal injury with frequent stair climbing [23].
In contrast, a population-based case–control study among patients in Sweden who had had orthopaedic surgery due to primary osteoarthritis of the knee did not find any association between climbing stairs and knee osteoarthritis [24]. Obesity is well established as a risk factor for the development of knee osteoarthritis [25]. However, the Norwegian offshore industry has weight limitations for getting an offshore health certificate, which excludes persons with high body mass index [26]. The possible relationship between walking on hard surfaces or climbing stairs on offshore installations and knee disorders should be investigated further.

Many cases of work-related musculoskeletal disorders were reported in catering and maintenance, and the dominant types of exposure were high physical workload and repetitive work. The work in many occupations in these categories, such as mechanics, electricians and catering assistants, includes heavy lifting, carrying and repetitive tasks. High physical workload and repetitive work are well-documented occupational risk factors for low-back pain and upper limb disorders [3]. However, comparing the relative numbers of reported work-related musculoskeletal disorders in different occupations is difficult in this study because the number of workers in each occupation is not known. The results do not therefore provide decisive information on which occupations pose the highest risk. In addition, for most of the workers there was no information about changes between job types, which may have skewed the results. Nevertheless, strategies for improving working conditions in catering and maintenance work should be considered. Control measures should be carried out, especially on the most frequently reported types of exposure: repetitive work and high physical workload. However, the recommendations are based on the physician’s evaluation in each case, and more studies on causality are recommended.

Key points

- Work-related musculoskeletal disorders accounted for nearly half of the reported cases of work-related diseases in Norway’s offshore oil industry from 1992 to 2003.
- Workers in maintenance represented the largest group of cases, upper limb and back were the most frequently reported anatomical regions and high physical workload and repetitive work dominated as the reported causes.
- The association between walking on hard surfaces/climbing stairs and ladders and knee disorders should be studied further.

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Conflicts of interest

None declared.

References

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