

Review Article

A Review of Epidemiological Injury Studies in the Oil- and Gas Offshore Industry

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Abstract

Safety and health in offshore oil and gas production has always been important. With the aim to evaluate the preventive program effect, a literature review was done based on epidemiological occupational injuries and musculoskeletal disorders.

Methods: A literature review was performed by examining papers in PubMed, Cochrane, EMBASE, Google Scholar and Web of Science databases that were published on or before January 1st 2000.

Results: i) The fatal injury incidence rates in the USA are significantly higher than for all other industries; ii) The incidence rates of lost time injuries have been reduced over the last decenia, which is probably due to the implemented preventive programs; iii) the prevalence rates of musculoskeletal disorders are similar to the general working populations.

Conclusion: The few epidemiological studies do not allow for firm conclusions and call for more studies. The fatal occupational injury risk in the oil- and gas platforms calls for more attention.

INTRODUCTION

Offshore oil and gas production is more challenging than land-based installations due to the remote and harsher environment. The dynamic nature of the platforms introduces many challenges for the drilling and production facilities. An offshore oil platform is a small community in itself with cafeteria, sleeping quarters, management, and other support functions. In the North Sea, staff members are transported by helicopter for a two-week shift. Supplies and wastes are transported by ship, and supply deliveries need to be carefully planned because storage space on the platform is limited. Offshore oil production involves accidents on the platforms and rigs and environmental risks from leaks during oil transporting from the platform to onshore facilities via tankers and pipelines.

Denmark has produced hydrocarbons since 1972, when the production commenced from the Dan field. Since 1997, Denmark has been more than self-sufficient in energy from the production of oil and gas in the North Sea. Since the Danish Energy Agency (DEA) was established in 1976, the Authority has dealt with matters relating to oil and gas activities in the Danish territory including supervision of the activities concerning safety and working environmental issues on platforms and drilling rigs. The

oil- and gas production installations on the Danish continental shelf in the North Sea, as well as drilling rigs and miscellaneous vessels associated with oil and gas production, provide jobs for up to 3,000 people. The employees have a multitude of different skills and include blacksmiths, electricians, geologists, engineers, painters, scaffolds', catering staff, medics, management, supervisors and operators etc. Drilling rig work schedules vary, and may involve working offshore for up to three weeks followed by three weeks off. The work schedule on board vessels follows the usual maritime practice. The offshore industry in the Danish sector of the North Sea has always focused intensely on reducing work related accidents and near miss. The industry has worked hard to implement accident prevention at all levels, from employees at the production/drilling plants to subcontractors and at management level. Over the years accident rates have been brought significantly down, but for several years the rates seem to have reached a steady-state. Therefore, the operators and the government have asked for new ways to handle the complex issue of further reduction of occupational injury rates. In order to establish a baseline, the objective of this study was to review the existing scientific literature on the occupational injury incidence rates and trends international in the offshore oil- and gas industry.

MATERIALS AND METHODS

Literature search

The following databases were searched for relevant articles: Medline and the Cochrane Database of reviews. The search was limited to articles in English, relating to human subjects, published between January 2000 and August 2012. Medline was searched with keywords “injuries”, “epidemiology”, “incidence”, “accident”, “offshore”, “petroleum”, “drilling workers”, and “oil and gas industry”. The Cochrane Database was searched with the same keywords. The literature search was done by using the words: “prevalence”, “offshore”, “oil and gas”, “cumulative trauma disorders”, “low back pain” and “musculoskeletal disorders”. Only three relevant studies were found. A “Google Scholar” searching was additionally applied and potentially relevant journals for specific search were found in the Electronic Library at the University of Southern Denmark. Fifteen relevant peer-reviewed journals, all indexed in Pub Med, were searched directly from their homepages one by one by using the words “offshore AND injury” offshore AND musculoskeletal”, but without revealing further results.

Article inclusion criteria

Articles were selected if they were published between 2000 and 2012, described prospective or retrospective studies of offshore occupational injuries or musculoskeletal diseases. Only articles reporting original denominator and nominator data were included. Acute cases with low back pain are often included in the injury statistics, and musculoskeletal disorders (MSD) that are developed gradually are normally not included in the injury statistics. But as the prevention of these disorders is highly important in the offshore health and safety system, studies of these disorders were included in this review. There is quite a lot of non-peer-reviewed information about safety in the oil and gas offshore sector, for example in the British Health and Safety Executive (www.hse.gov.uk/) and the Society of Petroleum Engineers (www.spe.org/). Specific information about the reported injuries is available on the Internet from the national responsible authorities. However, since the focus of the review is the precise calculation of incidence and prevalence rates, the reports without these data are excluded, except for some few with only case series.

RESULTS AND DISCUSSION

Occupational Injury incidence rates

Only two studies were found that included incidence rates. Two other relevant studies based on case series without incidence rates. The first incidence rate study analysed the fatal injuries in the USA oil and gas production, based on data from 1988-1990 and 2003-2004 [1]. Approximately 25% of U.S. oil and natural gas production comes from the offshore drilling rigs at sea. The oil and gas extraction in the USA employed approximately 380,000 workers on approximately 1,300 drilling rigs in 2006. The main result of the study is that the number of fatalities among oil and gas extraction workers increased from 85 fatalities in 2003 to 98 in 2004. The Centre for Disease Control and Prevention in the USA (CDC) analysed the data and found an annual fatality rate of 30.5 per 100,000 workers (404 fatalities) during 2003-2006,

approximately 7 times higher than the rate for all workers (4.0 per 100,000 workers). Nearly half of the fatalities are attributed to highway motor-vehicle crashes or being struck by machinery or equipment.

The CDC previously analysed the 1988 to 1990 incident reports from the International Association of Drilling Contractors [2], an industry-wide international trade association representing 95% of the world's oil and gas drilling companies. The overall non-fatal incidence rate in 1988 to 1990 was 1.2/100 full-time equivalents and the overall fatal incidence rate was 7.5/100,000 full-time equivalents.

The second study is in Dutch [3]. Based on the information in the figures, the incidence rates of all reportable injuries in ExxonMobil decreased sharply 1992 to 1993. This is mainly due to a reduction in the incidence rates of the contractors that operates supplementary to the main operator (Exxon Mobile Company). The incidence rates of the Exxon Company were much lower at the time when the contractors' rates decreased. There is no information whether a similar decrease may have happened in the Exxon Company. Further reduction in the incidence rates seems to demand intensive collaboration on prevention programs between operators and contractors.

Occupational injury studies without incidence rates

Statoil Exploration & Production Norway introduced a new system for categorisation and follow-up of undesirable incidents, including personal injuries twenty years ago. There were 24,400 registered undesirable incidents in the Norwegian division of Statoil for 2002. However, there is no information about the number of workers, and about the number of injuries included in the total number of undesirable incidents. Thus the incidence rates cannot be calculated [4].

A study of non-fatal injuries from Greece was based on data from the major injury-reporting system (MARS) and covers 6 years from 1997 to 2003 [5]. The figures cover the entire Greek Petrochemical Industry together with the Cyprus Refinery and range from extraction sites and offshore facilities to refineries, production and storage sites in Central and Northern Greece and on the island of Cyprus. The MARS is an injury information network, consisting of local databases in each Member State of the European Union and a central analysis system at the European Commission's Joint Research Centre in Ispra in North Italy. This system does not allow for calculation of epidemiological incidences rates. It is criticised that the information currently available at a European level is not sufficient to come to reliable conclusions regarding the frequency of such events [6]. However, a rough estimate can be calculated based on the total number of personnel working in this sector that reaches 5000 people from which more than 3000 are employees of the production and storage sites. There were 1024 major injuries during the 6 years and the rough estimate is 57 injuries reported per 100.000 workers. Due to lack of information about the injury inclusion criteria and lack of information of the number of hours worked, no comparisons can be made to the Danish Operators.

Work-related musculoskeletal disorders

According to work-related MSD, only three relevant studies

were found. Offshore workers from a Chinese oil company were invited to complete a self-administered questionnaire providing information on socio-demographic characteristics, occupational stressors, social support, coping style, health related behaviours, past injuries and musculoskeletal pain [7].

The prevalence of musculoskeletal pain over the previous 12 months varied between 7.5 % for elbow pain and 32% for low back pain; 56% of the workers had at least one complaint. Significant associations were found between various psychosocial factors and musculoskeletal pain in different body regions after adjusting for potential confounding factors. Occupational stressors, in particular stress from safety, physical environment, and ergonomics were important predictors of musculoskeletal pain.

The prevalence of MSD was assessed in a cross-sectional study in the year 2000 among employees in the UK oil and gas industry, predominantly on offshore installations [8]. Assessed by the Nordic Musculoskeletal Questionnaire (N=321), 80% of the sample reported that they had experienced some form of MSD in the past 12 months; 37% reported that they had experienced one or more problems over the past seven days. Low back problems were most frequently reported, 51% of the sample had experienced such problems in the past 12 months, and 17% during the past week. The prevalence rate of neck, shoulders and/or upper back MSD was also 17%. Mental health, workload, physical environment stressors, and body mass index predicted MSD with a different relative importance across different body areas.

A Norwegian review of epidemiological studies on health conditions among offshore petroleum workers included a few peer-reviewed publications and none with data illustrating incidences or prevalence after 2000 [9-12]. The authors expressed a doubt whether the prevalence of MSD differs from that among onshore workers. They propose that the main risk factors are physical stressors and a fast pace of work. Among catering personnel, these disorders are important causes of loss of the required health certificate and a need for further study in this area is stressed. Better knowledge of the causes of loss of the health certificate may contribute to preventing early retirement.

The work-related diseases from Norway's offshore petroleum industry notified by the physicians to the Petroleum Safety Authority were analysed [13]. For the period from 1992 to 2003, there were 6725 cases of work-related diseases out of which 3131 were musculoskeletal disorders (47%). The other large disease groups were hearing loss (25%) and skin diseases (15%). Among the musculoskeletal disorders, upper limb disorders accounted for 53%, back disorders for 20% and lower limb disorders for 16%, of which knee disorders dominated (12% of all cases).

The dominant occupational categories were maintenance work (40%) and catering (21%). Frequently reported types of exposure were high physical workload, repetitive work and walking on hard surfaces/climbing stairs and ladders. A total of 1709 cases of occupational hearing loss were reported with variable incidence of reported hearing loss, from 1 per 1000 in 1992 to 9 per 1000 in 2002, demonstrating that hearing loss is an important health challenge [14].

DISCUSSION

The fatal injuries in the oil and gas production in the US are seven times higher than for other workers in the US and the rate increased significantly from 1990 to 2004. However, this study includes both onshore and offshore accident data (and more than half of the accidents happened in the traffic), so the results cannot be compared with results from other countries. The trend analyses of the injury incidence rates from different countries can be useful assess the effect of the implemented safety programmes. Based on the Dutch study, the safety system in the Exxon Mobil Company has obviously been very effective. Their hired contractors are more slowly adapting to similar risk prevention systems due to the "Operations Integrity Management System." integrated in all aspects of the company's activities. Due to the success of the program, it might be wise to learn from the program. The studies of musculoskeletal disorders show that the prevalence of complaints and disorders are on the same levels as in the general population. The causes of the disorders are multiple including psycho-social factors.

Based on a comprehensive search for occupational injury incidence rate studies, only two studies based on national data on occupational injuries in the oil- and gas offshore industry after 2000 and no international studies could be found. The American study analyses the fatal injuries in the US oil and gas production, based on data from 1988-1990 and from 2003-2004. The fatal injury incidence rate in 2003-2006 was seven times higher in the USA oil and gas productions than for the other industries in the USA. Approximately 75% of U.S. oil and natural gas production comes from onshore areas and half of the fatal injury is traffic injuries. The fatal injury incidence rate during 2003-2006 of 30.5 per 100,000 workers is much higher than the incidence rate of 7.5 per 7.5/100,000 full-time equivalents for 1988 to 1990. The results might be biased due to different calculation of full-time equivalent (workers) in the two data collection periods. Another possible source of bias is that the data from 1988 to 1990 was collected from nearly all drilling contractors, while the data for 2003-2006 is only for the USA. As the USA data comes from both onshore and offshore production, the data cannot be compared with other countries with predominant offshore oil and gas production.

In the Dutch study, the injury incidence rates of all reportable injuries decreased dramatically from year 1992 to 1993 among the contractors [15]. This level among the contractors had been kept on a level of about 40 injuries per 1 million working hours and decreased to about 10 per 1 million hours. The dramatic decrease in the rates did not occur according to injuries among Exxon Mobile employees, the company had already reduced the incidence to a lower level with less than 10 injuries per 1 million working hours in 1987-1989. The company informed that the risk prevention success is due to the "Operations Integrity Management System" (OIMS) which is a comprehensive and effective safety program that is integrated in all aspects of the company activities. Therefore it might be wise to learn from the program.

The MSD studies among Chinese and British offshore petroleum workers [7,8] show that these disorders are indeed common and causally related to many different risk factors,

including psycho-social factors. The authors of the Norwegian review of musculoskeletal diseases expressed a doubt whether the prevalence of musculoskeletal disorders differs from that among onshore workers and the same was expressed in the British study [9]. The notified work-related diseases among Norwegian offshore workers are the results of long time exposures and do not represent the actual working conditions [12-13].

Overall, besides the few existing scientific publications, the administrative reports can be used for documentation of health and safety promotions. However, there may be problems with their quality compared to peer-reviewed publications. The methods are not always sufficiently described. The definitions of the injury inclusion criteria or the study populations are absent or unclear. Even where the research quality is good, it may be difficult to get copies of the reports. Another problem arises with reports written in languages other than English. The methodical problem hinders for a wide international use of the results and collaboration between the companies and nations and is an impediment to the establishment of international evidence based injury preventive initiatives.

CONCLUSION

There is a need for more epidemiological studies of injuries and of work-related diseases on the oil- and gas offshore platforms in order to identify the specific areas that need attention for health and safety promotion.

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