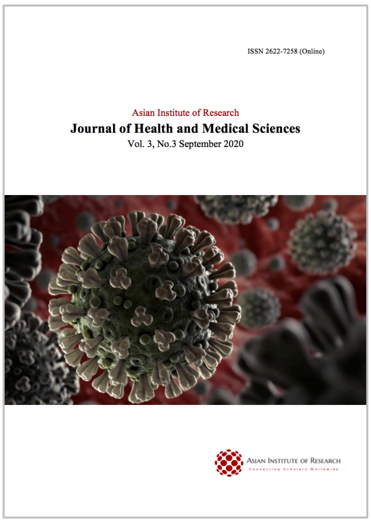

Journal of Health and Medical Sciences

McNamara, Rachel, and Smith, Andrew P. (2020), Combined Effects of Fatigue Indicators on the Health and Wellbeing of Workers in the Offshore Oil Industry. In: *Journal of Health and Medical Sciences*, Vol.3, No.3, 270-276.

ISSN 2622-7258

DOI: 10.31014/aior.1994.03.03.122

The online version of this article can be found at:
https://www.asianinstituteofresearch.org/

Published by:
The Asian Institute of Research

The Asian Institute of Research
Journal of Health and Medical Sciences
Vol.3, No.3, 2020: 270-276
ISSN 2622-7258

DOI: 10.31014/aior.1994.03.03.122

Combined Effects of Fatigue Indicators on the Health and Wellbeing of Workers in the Offshore Oil Industry

Rachel McNamara[1], Andrew P Smith[1]

[1] Centre for Occupational and Health Psychology, School of Psychology, Cardiff University, 63 Park Place, Cardiff. CF10 3AS. Wales, UK

Correspondence: Andrew P Smith. Email: smithap@cardiff.ac.uk

Abstract
Offshore workers are exposed to a unique combination of factors that may impact negatively on well-being. This paper describes results from a survey of fatigue, health and injury amongst seafarers and installation personnel working in the UK sector of the offshore oil industry. Potential stressors and fatigue- related variables (e.g. noise, working hours, and shift) were considered in terms of their combined effects on subjective outcome measures. Median splits of these variables were summed to create a 'total fatigue indicators' score. A quartile split of this variable was entered into a series of analyses of covariance (ANCOVA), co-varying age, education and socio-economic status (SES) and stratifying for occupational group (i.e. seafarers or installation personnel). Total fatigue indicators demonstrated a linear effect on depression, cognitive failures, social functioning, lack of/poor quality sleep, fatigue, and the home-work interface. Effects were more pronounced amongst installation personnel than seafarers. This is possibly due to fundamental differences in shift systems between the two groups of offshore workers. No significant effects were observed for injury frequency, prescribed medication or smoking and alcohol consumption. Results suggest that exposure to a combination of stressors has a significantly greater negative effect on health than any of these factors in isolation.

Keywords: Psychology, Occupational Medicine, Epidemiology, Fatigue; Combined Effects

1. Introduction

The purpose of the present paper is to describe a survey that was carried out to determine the extent of fatigue and poor health offshore. The term 'offshore' refers in this instance, to all personnel employed in the UK sector of the offshore oil industry, who work tours of duty between two and four weeks in length, either on installations or on support and supply vessels. It was hoped that this might provide some indication, not just of injury likelihood, but of chronic problems that may occur as a result of working in an offshore environment.

Extreme weather conditions, noisy working environments and demanding work and rest patterns may all contribute to fatigue and poor health offshore (Parkes 1997, 1998). Furthermore, major economic, structural and technological changes have taken place within the industry in recent years, often resulting in reduced manning, increased workload and job insecurity (e.g. Collinson 1998). All of these factors, either alone or in combination, may have a negative impact on the health and well-being of offshore workers.

A number of studies of stress and health offshore have been undertaken in recent years, yet fatigue is rarely examined specifically. Furthermore, surveys are for the most part limited to offshore installation personnel. What is apparent from the self-reported data however, is that increased workload, long hours, poor quality or lack of sleep and boredom do indeed contribute to poor mental health and fatigue offshore (Parkes 1997, Parker et al. 1997). However, some studies have failed to demonstrate significantly poorer levels of health amongst installation personnel, and have therefore concluded that they are no worse off than their onshore counterparts (Gann et al. 1990).

The current survey was designed to identify all aspects of the working environment that may impact on the health and general well-being of personnel employed in all sectors of the offshore oil industry. By drawing comparisons between installation workers and seafarers, it is hoped that risk factors inherent in these diverse occupations can be reduced, and in some cases eliminated. Previous research (e.g. Smith et al. 2000, 2001) has shown the relationship between exposure to one or more occupational hazards (e.g. noise, shift work) and poor health to be linear. In light of this, the purpose of the present analyses was to examine the impact of workplace factors in combination, as individuals in an offshore environment are likely to be exposed to a number of negative factors at any one time.

2. Material and methods

2.1 Survey Content

The main aim of the survey was to assess the work and rest patterns of seafarers and offshore installation workers. More specifically, to assess the extent to which working hours, shift patterns and time spent offshore were associated with fatigue, accidents and injuries, and poor physical and mental health of crewmembers. The questionnaire was designed to encompass all aspects of life offshore. It was divided into the following three sections:

1. Offshore: included questions relating specifically to work patterns, and subjective measures of attitudes towards work.
2. On leave: included subjective measures of health, wellbeing and health-related behaviours such as eating, drinking, smoking and exercise.
3. Life in general: included a number of standardised scales of wellbeing, such as the General Health Questionnaire (GHQ: Goldberg 1972), the Profile of Fatigue-Related Symptoms (PFRS: Ray 1991), the Cognitive Failures Questionnaire (CFQ: Broadbent et al. 1982) and the MOS Short Form Health Questionnaire (SF-36: Ware et al. 1993).

2.2 Participants/Procedure

The questionnaire was distributed to the home addresses of members of the seafaring officer's union, NUMAST and the installation worker's union, MSF. Secondly, questionnaires were distributed to seafarers onboard offshore oil support vessels operating in the UK sector, by visiting researchers. A short version of the questionnaire was sent to a group of onshore workers, as a control for items specifically relating to fatigue. Results were also compared with normative data from three other sources: a sample of 93 onshore workers who participated in a study of workplace stressors, (Smith et al. 2001), a random sample (N=8092) of the working population taken from the Welsh Health Survey (The National Assembly for Wales 1998), and data (N=3220) from the Bristol Health and Safety at Work Study (All three control groups served as comparative norms for scores on the health and well-being scales, e.g. GHQ, CFQ, SF-36 - Smith et al. 2000).

2.3 Response rate

1600 questionnaires were sent out to NUMAST members and 563 were returned (35.2% response rate). 1800 questionnaires were sent to MSF members and 388 were returned (21.6% response rate). 53 questionnaires were returned by offshore support crew and 93 questionnaires were sent to onshore controls and 71 were returned (76.3% response rate).

3. Results

Potential stressors and fatigue related variables (e.g. high levels of noise, long working hours and rotating versus fixed shifts) were considered in terms of their combined effects on outcome measures (i.e. subjective reports of physical and psychological health). ANCOVAs were carried out on offshore groups only as the sample size in the onshore control group was deemed insufficient.

3.1 Statistical Methods

Median splits of potential stressors were examined in pairs [Where 1=1ow exposure, 2=high exposure.], and summed to create a 'total fatigue indicators score'. These comprised 'number of hours worked per week', and the following working hours and physical hazards variables: night work, shift work, unsociable hours, breathing fumes/harmful substances, touching/handling harmful substances, ringing in the ears, background noise, vibration and motion sickness [Responses to all working hours and physical hazards variables were scored from 1-4: 1=never,2=seldom, 3=sometimes, 4=often.]. Median splits of the following items relating to job demand [Taken from Siegrist's Effort-Reward Imbalance Model (1996): 1=Not at all distressed, 4=Very distressed.] were also included:

- 'I have constant time pressure due to a heavy workload'
- 'I have many interruptions and disturbances in my job'
- 'I have a lot of responsibility in my job'
- 'I am often under pressure to work overtime'
- 'I have experienced or expect to experience an undesirable change in my work'
- 'My job promotion prospects are poor'
- 'My job security is poor' and
- 'I am treated unfairly at work'

Shift schedule was split into two categories (i.e.'fixed or rotating') as was shift length (i.e. 'long' versus 'short'). These items were also included in the 'total fatigue indicators score'. A quartile split of this composite variable was then entered into a series of analyses of co-variance (ANCOVA) co-varying age, education and socio- economic status (SES) and stratifying for occupational group (i.e. seafarers or installation personnel).

3.2 Descriptive Statistics

The seafarers had a mean age of 43.7 years (s.d.=9.55), the installation workers 45.6 years (s.d.=7.8) and the onshore controls 39.2 years (s.d. = 12.29). The seafarers and installation workers did not differ in terms of marital status or education. Over 75% of the seafarers were in senior ranks compared to 20% of the installation workers. This is not surprising as the seafarers were contacted through the officers' union. The shift systems and the work hours of the seafarers and installation workers are shown in Table 1.

3.3 Shift Systems

There were several major differences in the work and leave systems reported by seafarers and installation workers. For example, the most common work/leave cycle for seafarers is the 4 weeks-on, 4 weeks-off cycle. However, less than 1% of workers on offshore installations work this system. Over 3/4 of installation personnel work a 2 weeks-on, 2-weeks off schedule. Furthermore, seafarers appear more likely than installation personnel to work fixed shifts.

3.4 Work Hours

There were also significant differences in work hours within these shift systems: more than twice as many installation respondents as seafarers work 12-hour shifts. As the nature of seafaring often demands personnel to 'keep watch', 6 hours-on, 4-off and 4-on, 4-on and 8-off systems are common. However, despite these differences in shift patterns between the two offshore groups, both report significantly higher weekly hours than onshore workers. It is also evident that offshore personnel tend to do more hours of overtime per day than onshore workers (N.B. mean additional daily hours were higher still in the seafaring group than amongst installation workers).

Table 1: Shift systems and working hours

	Seafarers %	Installation workers %	Control Group %
4 week schedule	65.7	0.8	-
2 week schedule	1.2	78.1	-
12 hour shifts	41.4	87.5	-
Fixed shifts	75.1	48.5	-
>60 hours a week	93.0	93.3	5.8
3-5 hours overtime	24.5	17.8	9.8
2-3 days to adjust	50.1	43.6	-
12 hours on 12 off	41.4	86.9	-
6 hours on 6 off	22.4	12.4	-
4 hours on 8 off	18.1	-	-
4hours on 4 off	0.2	-	-

3.5 Adjustment to Shift Systems and Work Hours

A significant proportion of respondents in both offshore groups reported feeling 'below par' on returning to their vessel/installation after a period of leave, although this was more marked in the case of installation workers (reported by 44.6% as opposed to 25.2% of seafarers). Furthermore, approximately half of all respondents felt that adjusting to life offshore took at least 2-3 days. Perhaps of more concern, is the fact that 45.1% of seafarers and 63.7% of installation workers felt their performance to be affected during this period of adjustment.

3.6 *Mental and Physical Fatigue*

Table 2 shows the percentage of workers in each group who reported feeling very or extremely tired at the end of their working day.

Table 2: Mental and physical fatigue of the different groups of workers

	Mentally tired (very/extremely) %	Physically tired (very/extremely) %
Seafarers	52	39
Installation workers	62	52
Control group	48	54

As is evident from the graph, those who work in an offshore environment are more likely to report feeling mentally tired at the end of the working day than onshore workers. This pattern was reversed for physical tiredness.

3.7 Fatigue-Related Incidents

The percentage of respondents who report being involved in at least one fatigue-related incident was highest amongst installation workers (reported by12.9% of respondents, as compared to 6.6% of seafarers and 10.1% of controls). However, the proportion of respondents reporting involvement in 3-4 fatigue-related incidents was very similar across all three groups.

3.8 Further Analysis: Analyses of covariance

Where pairs of stressors were examined in combination, there was evidence to suggest that exposure to two hazards resulted in reduced wellbeing compared to exposure to a single hazard. However, this was not the case for all combinations studied. If one takes GHQ scores as an example of a typical outcome variable, there were no additive effects of background noise and night work (main effect of noise: $F [1, 849] = 15.34, p<.0001$), background noise and unpredictable hours (main effect of noise: $F [1, 845] = 15.26, p<.0001$) night work and exposure to hazards (main effect of hazards: $F [1, 848] = 5.78, p<.02$), night work and level of responsibility (main effect of responsibility: $F [1, 848] = 30.35, p<.0001$) and night work and unfair treatment (main effect of unfair treatment: $F [1, 849] = 48.65, p<.0001$).

However, additive effects were observed for the following example pairings: 'long/unsociable working hours' and noise (Workhours: $F [1, 842] = 17.56, p<.0001$; Noise: $F [1, 842] = 8.76, p<.0001$) and shift schedule and time pressure (Shift: $F [1, 789] = 4.27, p<.04$; Time pressure: $F [1, 789] = 29.68, p<.0001$). Table 3 shows the mean GHQ scores for each of these groups.

Table 3: Mean GHQ scores (s.d.s in parentheses) for different combinations of hazards

Noise and working hours	Low noise/low hours	Low noise/high hours	High noise/low hours	High noise/high hours
	1.13 (2.22)	1.51 (2.34)	1.66 (2.56)	2.55 (3.15)
Shifts and time pressure	Fixed shift/low pressure	Rotating shift/low pressure	Fixed shift/high pressure	Rotating shift/high pressure
	1.14 (2.21)	1.54 (2.34)	2.08 (2.80)	2.99 (3.33)

The means in Table 3 suggest a linear relationship between combinations of hazards and mental health. In order to further test this, and to determine whether greater variance in wellbeing could be explained, a 'total fatigue indicators score' was calculated across all possible hazards.

3.9 *Total Fatigue Indicators Score*

Significant effects of the composite fatigue indicators score were found on virtually all subjective measures of health and well-being, including mental health (GHQ Score $F [1, 739] = 35.38, p<.0001$), cognitive failures (CFQ $F [1,723] = 29.62, p<.0001$), fatigue (PFRS fatigue $F [1, 732] = 43.37, p<.0001$), physical functioning (SF-36 physical functioning $F [1, 735] = 5.55, p<.0001$), social functioning (SF-36 social functioning $F [1, 732] = 36.32, p<.0001$), job stress ($F [1, 732]= 53.38, p<.0001$), life stress ($F [1, 737] = 7.17, p<.0001$), lack of sleep ($F [1, 735] = 25.66, p<.0001$), poor quality sleep ($F [1, 739] = 34.31, p<.0001$), physical ($F [1, 745] = 31.32, p<.0001$) and mental fatigue ($F [1, 744] = 38.93, p<.0001$), and aspects of the home-work interface, including: 'problems at work make you irritable at home' ($F [1, 728] = 9.55, p<.0001$) and 'job takes up too much energy' ($F [1, 731] = 34.65, p<.0001$). Means and standard deviations for the outcome measures are shown in Table 4.

Table 4: Mean outcome scores (sds in parentheses) for the 4 quartiles of the total fatigue indicators score (high scores = reduced wellbeing apart from social functioning where high scores = better wellbeing)

Outcome	1st Quartile	2nd Quartile	3rd Quartile	4th Quartile
GHQ	0.59 (1.28)	1.25 (2.09)	2.22 (2.75)	3.17 (3.44)
CFQ	32.50 (11.85)	36.62 (11.79)	40.40 (13.20)	44.13 (13.65)
SF-36 Social Functioning	94.31 (14.14)	88.24 (17.67)	80.10 (22.16)	72.62 (22.68)
Poor quality sleep	1.97 (0.75)	2.36 (0.83)	2.55 (0.86)	2.80 (0.88)

Job stress	1.95 (0.78)	2.40 (0.94)	2.64 (0.90)	3.08 (0.95)
Physical Fatigue	2.08 (0.62)	2.32 (0.65)	2.50 (0.66)	2.72 (0.68)
Mental fatigue	2.22 (0.66)	2.55 (0.67)	2.77 (0.64)	2.93 (0.71)
Irritable at home due to problems at work	1.32 (0.50)	1.53 (0.60)	1.76 (0.60)	1.67 (0.65)

3.10 Injuries and Health-Related Behaviours

No significant effects of the total fatigue indicators score were observed for injury frequency, use of prescribed medication or smoking and alcohol consumption.

3.11 Occupational group

Installation workers were significantly worse for the following outcomes: GHQ (Occupational Group: F [1, 711] =25.28, p<.0001), SF-36 social functioning (F [1, 709] = 10.46, p <.001), PRFS fatigue (F [1, 709] = 11.94, p<.001), physical fatigue (F [1, 720] = 6.42, p<.01), mental fatigue (F [1,720] = 13.02, p<.0001), job stress (F [1, 708] = 4.42, p<.04), life stress (F [1, 712] = 8.25, p<.004), lack of sleep (F [1, 720] = 25.07, p<.0001),'problems at work make you irritable at home' (F [1, 704] = 30.18, p<.0001) and 'job takes up too much energy' (F [1, 704] = 37.69, p<.0001).

3.12 *Demographics*

Functioning on the following measures was found to deteriorate with age: CFQ (F 1, 706] = 6.52, p<.01), SF-36 physical functioning (F [1, 712] = 24.99, p<.0001) and physical fatigue (F [1, 720] = 5.09, p<.01). Low socio-economic status was associated with increased life stress (F [1, 712] = 4.51, p< .03), mental fatigue (F [1, 720] = 3.95, p<.05) and 'problems at work make you irritable at home' (F [1, 704] = 4.81, p<.03). Low educational status negatively influenced mental fatigue only (F [1, 720] = 4.18, p<.04).

3.13 *Summary of Findings*

These results suggested that physical and psychosocial hazards in the offshore environment combine additively to produce a linear effect on a wide range of health and wellbeing outcome measures. Furthermore, this effect was more marked when a range of stressors were combined additively (as opposed to studying pairs of hazards). They did not however, appear to demonstrate these effects on health-related behaviours or injury frequency. The pattern of significance suggested that installation workers were worst off on the majority of outcome measures (as compared to both seafarers and onshore norms), and not surprisingly, that cognitive ability and physical functioning deteriorate with age.

4. Discussion

These results clearly demonstrate that exposure to a combination of workplace stressors has a significantly greater negative impact on subjective measures of health and well-being than any one 'hazard' in isolation. Furthermore, installation workers appear worse off in terms of wellbeing than their seafaring counterparts. This may be explained in part by the differences in shift systems between the two groups: installation workers tend to work fast rotating as opposed to fixed shifts, which have previously been demonstrated to be the most detrimental shift pattern in terms of health and performance (e.g. Wilkinson, 1992). This idea requires further clarification however: future research in the area might therefore wish to investigate this issue.

There are a number of problems inherent in the type of methodology used in this study. It was not possible to determine causal relationships from a cross- sectional survey. Although the results suggest that working in an offshore environment is detrimental to health, the possibility that poor health may lead to a more negative perception of working patterns cannot be ruled out. Individual differences such as negative affectivity may create reporting biases amongst those who seem to be most affected. These difficulties could be overcome in future by employing longitudinal or intervention studies, although an approach of this nature might prove difficult to implement from a practical point of view. Co-varying negative affectivity may provide a more suitable alternative (see Smith et al. 2001).

As part of a research project examining fatigue and health amongst the seafaring population (Smith et al. 2001), onboard studies of the relationships between working patterns and objective performance, sleep and physiological parameters were carried out. It is hoped that this approach will lead to a clearer picture of the effects of life offshore on the workforce, which will enable policy makers and commercial organisations to follow a common standard of best practice.

The current research highlights the potential for fatigue in an offshore environment. Although it was not clear in this instance what the consequences of this might be in terms of injury and accident causation, future research should seek to examine this link as the environmental, financial and personal costs of such a causal relationship are potentially devastating. It is already clear that a revision of working practices within the industry would greatly improve the wellbeing of the workforce.

Acknowledgement: This research was funded by the UK Maritime and Coastguard Agency, the UK Health and Safety Executive and the Cardiff Seafarers International Research Centre.

References

Broadbent, D.E., Cooper, P.F., Fitzgerald, P. & Parkes, K.R. (1982). The Cognitive Failures Questionnaire (CFQ) and its correlates. Br J Clin Psychol 21: 1-16.

Collinson, D.L. (1988). "Shifting lives": Work-home pressures in the North Sea oil industry. Can Rev Soc & Anthrop 35: 301-324.

Gann, M., Corpe, U. & Wilson, I. (1990). The application of a short anxiety and depression questionnaire to oil industry staff. J Soc Occ Med 40: 138-142.

Goldberg, D. (1972). The detection of a psychiatric illness by questionnaire. Oxford University Press, London.

Parker, A.W., Hubinger, L.M., Green, S., Sargent, L. & Boyd, R. (1997). A survey of the health, stress and fatigue of Australian seafarers. Australian Maritime Safety Authority.

Parkes, K.R. (1997). Psychosocial aspects of work and health in the North Sea oil and gas industry, part 1: review of the literature. Health and Safety Executive, HSE Books. Publication 523, Sudbury, Suffolk.

Parkes, K.R. (1998). Psychosocial aspects of stress, health and safety on North Sea installations. Scand J Env & Health, 24: 321-333.

Ray, C. (1991). Chronic fatigue syndrome and depression: Conceptual and methodological difficulties. Psychosoc Med 21: 1-9.

Siegrist, J. (1996). Adverse health effects of high-effort - low reward conditions at work. J Occ Health Psy 1: 27-43.

Smith, A.P., Brice, C., Sivell, S. & Wellens, B. (2001). The combined effects of occupational factors on subjective reports of health. In: Contemporary Ergonomics. MA Hanson (ed), Taylor & Francis, London, pp 197-202

Smith, A.P., Johal, S.S., Wadsworth, E., Davey-Smith, G. & Peters,T. (2000). The scale of occupational stress: The Bristol stress and health at work study. HSE Books Report 265.

Smith, A.P., Lane, A.D., Bloor, M. (2001). Fatigue offshore: A comparison of offshore oil support shipping and the offshore oil industry. SIRC Technical Report Series, ISBN No: 1-900174-14-6.

The National Assembly for Wales (1998). The Welsh Health Survey, 1998.

Ware, J.E., Snow, K.K., Kosinski, M. & Grandek, B. (1992). SF-36 health survey manual and interpretation guide. Boston: MA. The Health Institute, New England Medical Centre.

Wilkinson, R.T. (1992). How fast should the night shift rotate? Ergonomics. 35: 1425-1446