

Sleep disturbances among offshore fleet workers. A questionnaire-based survey

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ABSTRACT

Background. Shift work is related to fatigue and desynchronization with the external environment. This study investigates how 6-h shifts and 12-h shifts affects sleep and safety in workers onboard offshore supply vessels, and if any differences exist between the two working schedules.

Material and methods. A questionnaire study was carried out in the North Sea, Australia, Africa, South America, and the Far East, with 577 participants. The offshore fleet workers gave information on parameters related to sleep disturbances, causes of sleep disturbances, and safety. Regional differences in these parameters were also investigated.

Results. Workers on 6-hour shifts reported significantly more sleep problems than 12-hour shift workers did ($p < 0.01$). The 6-hour workers were more affected by noise ($p < 0.01$) and shift-work itself ($p < 0.01$).

Conclusions. Those working 6-hour shifts suffer more from sleep disturbances than those on 12-hour shifts, but this is not reflected in the perception of safety within the individual. Noise and shift-work itself is more of a problem in the 12-hour workers. Differences in safety culture and work morale are likely to cause the differences between regions.

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Key words: shift work, offshore fleet, sleep disturbances, fatigue

INTRODUCTION

Shift work is well known to cause sleep deprivation, cognitive deficits, and general fatigue due to the desynchronization with the external environment [1–3]. Offshore operations need to be performed around the clock in all weather conditions. Especially in the offshore fleet these challenges become pronounced due to exposure to the natural environment causing vessel motion, noise, and vibration [4–6]. Disturbed sleep is the most common consequence of a change in the sleep/wake pattern [7] and it significantly affects the workers well-being.

The most frequently used shift work schedules are 6-hour shifts (6.00–12.00/18.00–00.00 or

12.00–18.00/00.00–6.00) and 12-hour shifts (6.00/18.00–18.00/6.00). Daily sleep durations of less than 7 hours cause gradual performance impairment across days [8], and oral statements from offshore vessel workers indicate that adequate sleep is difficult to achieve due to the fast rotating schedule. Twelve-hour shifts give the workers an opportunity, in theory, to get a full night or a full day of uninterrupted sleep after the end of the shift. However, 12-hour shifts are long and continuous work durations over 8 hours increases the risk of accidents [9].

Twelve-hour shifts have been studied on oil platforms in the North Sea [10–12], and Bjorvatn et al.

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[10] found that oil platform workers rapidly adapted to a 12-hour shift schedule. This might be one of the reasons why 12-hour shifts are more desirable. If 12-hour shifts are to be considered a worthy alternative to 6-hour shifts, these needs to be investigated in further detail.

Thus, the aim of this paper is to specifically investigate offshore fleet shift workers on 6-hour and 12-hour shifts and their sleep disturbances onboard and at home, the causes of sleep disturbances, and if this compromises safety. Given the same shift schedule, it is also of interest to see whether there are regional differences in these parameters, since Africa, South America, the Far East, and Australia are rapidly expanding areas of offshore activity.

HYPOTHESIS

It is hypothesized that those working 6-hour shifts generally suffers more from sleep disturbances and sleep problems than those working 12-hour shifts and that this is perceived as a safety risk. The causes of sleep problems are largely identical for both shifts, but the sleep disturbances are unique for working at sea. Further, there are regional differences due to the perceived experience of the investigated parameters and due to other climatic conditions.

MATERIAL AND METHODS

PARTICIPANTS

A Norwegian based shipping company with vessels operating in the North Sea, Africa, South America, the Far East, and Australia started a multiple year project that focused on different aspects of health among its workers. A total of 577 workers were enrolled in the study, and they all signed a written consent form to participate in the study.

DATA COLLECTION

The data used in this paper were derived from a larger questionnaire-based survey carried out in 2007 by Geving et al. [13]. The questionnaire comprised background information, physical activity, diet, sleep and shift-working, smoking, physical work environment, musculoskeletal problems, bullying & harassment, and work content, social condition, and roles. We specifically used the data about sleep/shift work to address the hypotheses of this paper. In brief, personal interviews with workers in the offshore vessel fleet were conducted. The offshore vessel fleet is comprised of Platform Supply Vessels (PSV), Anchor

Handling Tug Supply vessels (AHTS), and Inspection, Maintenance, and Repair vessels (IMR). The interview focus was on their subjective opinions concerning factors that impacted their health and working environment on board and elucidated their personal preferences and needs as regards how to improve the situation. From the interviews, the statements were selected and developed into a questionnaire that focused on the factors mentioned earlier (see above). The questionnaire was available in English and Norwegian, and all data were anonymous. The survey was carried out according to the Norwegian Social Science Data Services (NSD), and permissions were granted. The questionnaire was distributed to crews on the vessels reporting to the shipping company headquarters in Norway, the UK, and Australia. The respondents returned the completed form in a sealed envelope so that they could be returned in bulk from each vessel and identified by the vessel's name. As a motivational factor, the management of the shipping company promised a prize to the crew with the highest response rate.

The questions regarding sleep and shift-working were: How often do you suffer from sleep disturbances? In the course of the past year, have you had sleep problems that have affected your ability to work and work safely? What are the causes of your sleep problems during your periods at sea? Do you have similar problems at home?

STATISTICAL ANALYSIS

The statistical analysis was performed by using Microsoft Excel 2007 (Microsoft Office Excel 2007) and the software package SPSS for Windows 16.0 (SPSS Inc., Chicago, Illinois). To assess the distribution of incidents we used the SPSS frequency analysis function to count the responses and to calculate the cumulative percentage. Graphs were modelled in both programs. All of the analysed variables were non-parametric nominal or ordinal data, and were tested for significant differences between 6-hour and 12-hour shift workers by using Pearson Chi-Squared tests (χ^2). All reported p-values were made on the basis of two-tailed tests and differences were considered statistically significant at $p < 0.05$.

RESULTS

A total of 577 questionnaire forms were completed and returned to the study coordinators. The data were divided into those working 12-hour shifts, 6-hour shifts, and other shifts employed (Figure 1). The subject characteristics are shown in Table 1.

SLEEP DISTURBANCES

The workers on the 6-hour shifts reported significantly more sleep problems than did 12-hour shift workers ($p < 0.01$) (Figure 2). Almost twice as many on the 6-hour shift reported sleep problems more than once a week (30.7%) compared to the 12-hour shift workers (17.7%). Sleep problems occurring never, or only a few times a year were reported by almost half of the respondents in 12-hour shift workers (43.1%), but only by 31.5% of the 6-hour shift workers. Sleep disturbances occurring once or twice a month or about once a week were relatively equally distributed.

WORK CAPABILITY AND SAFETY AT WORK

The work capability or safety at work did not show any differences between the groups (Figure 3). Thus, despite the sleep disturbances reported in Figure 2, there is a rather uniform agreement that safety is not compromised.

CAUSES OF SLEEP PROBLEMS

The causes of sleep disturbances are largely identical in both groups, and there seems to be a uniform agreement in what causes sleep disturbances (Figure 4). The 6-hour shift workers are, however, significantly more affected by noise ($p < 0.01$) and shift working ($p < 0.01$), whilst other problems ($p < 0.01$) are reported higher in the 12-hour shift workers.

SLEEP PROBLEMS AT HOME

Figure 5 shows that the majority of the workers in both groups do not have the same sleep problems as when residing at home. There were no significant differences between the groups of workers. It therefore seems as if this is a unique situation for the workers when they are working offshore and that this is imposed by the work itself.

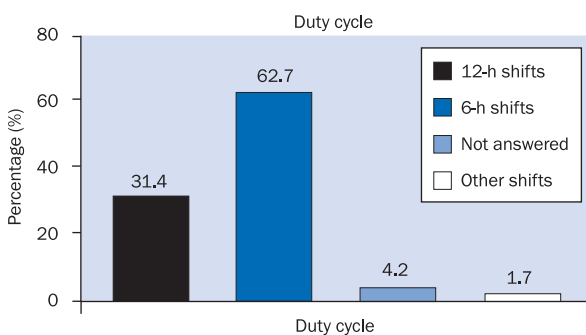


Figure 1. The distribution of vessels in 6-h and 12-h shift workers (total N = 577)

REGIONAL DIFFERENCES IN SLEEP DISTURBANCES

Regional differences in sleep disturbances are shown in Table 2. In 6-hour shift workers there were regional differences in how often the workers suffered from sleep disturbances ($p < 0.01$); sleep problems that affected safety ($p = 0.03$); poor sleep hygiene i.e. bad mattress/pillow/duvet ($p = 0.04$); cabin temperature/humidity ($p < 0.01$); need to get up to urinate ($p < 0.01$); unsafe conditions onboard ($p < 0.01$); and other causes of sleep disturbances ($p < 0.01$).

In 12-hour shift workers there were regional differences in how often the workers suffered from sleep disturbances ($p < 0.01$); sleep problems that affected safety ($p < 0.01$); noise ($p = 0.02$); poor sleep hygiene i.e. bad mattress/pillow/duvet ($p = 0.04$); cabin temperature/humidity ($p = 0.04$); need to get up to urinate ($p = 0.03$); unsafe conditions onboard ($p < 0.01$); physical problems; ($p < 0.01$) and other causes of sleep disturbances ($p = 0.01$).

DISCUSSION

The analysis of the questionnaires revealed an expected pattern, namely that workers on the 6-hour shifts experience more sleep problems than their colleagues on the 12-hour shift.

SLEEP DISTURBANCES

The sleep disturbances reported in Figure 2 shows that 6-hour shift workers suffer of almost twice as many sleep disturbances compared to 12-hour shift-workers. It therefore seems to be the organization of the shift work that plays a crucial role in sleep disturbances, since both the 6-hour and the 12-hour shifts work exactly the same number of hours. Workers on 6-hour shifts are faced with the challenge of never having the chance to fully recuperate and to get the opportunity of a full night or day of sleep. The six hours between each shift in the group of 6-hour shift workers are hardly enough to eat, shower, and engage in social activities in addition to getting adequate sleep of a sufficient quality and length. This is in contrast to workers on 12-hour shifts that can, after eating, showering, and taking care of other daily needs, get in the vicinity of 11 hours of full uninterrupted sleep. A study of 6-hour shifts (6 hours on/6 hours off) in a bridge simulator [14] showed that sleepiness was severely affected during the night shift (00.00–6.00 hours) and during the morning shift (6.00–12.00 hours). Sleepiness also progressed severely during the duration of each shift. Other stu-

Table 1. Subject characteristics

	6-6		12-12	
	(%)	n	(%)	n
Age				
29 or less	17.1	62	21.0	38
30–39	26.8	97	20.4	37
40–49	27.3	99	29.8	54
50 or more	28.5	103	28.7	52
Not answered	0.3	1		
Sex				
Male	92.3	334	89.5	162
Female	2.2	8	5.5	10
Not answered	5.5	20	5.0	9
Position				
Captain	13.0	47	4.4	8
Deck officer	26.5	96	11.0	20
Engine officer	18.2	66	19.9	36
Cook	0.3	1	20.4	37
Able seaman/IR	32.6	118	12.2	22
Engine rating/Engine room IR/Oiler	2.5	9	3.9	7
Cadet/Trainee	4.4	16	2.8	5
Electrician/ETO	1.7	0	10.5	19
Other	1.7	6	13.3	24
Not answered	0.8	3	1.7	3
Experience as seaman				
0–5 years	17.7	64	22.7	41
6–10 years	12.4	45	12.7	23
11–15 years	14.1	51	15.5	28
Over 15 years	54.7	198	48.6	88
Not answered	1.1	4	0.6	1
Vessel type				
Anchor handling tug (AHT)	40.3	146	37.6	68
Platform supply vessel (PSV)	54.1	196	37.6	68
Standby vessel	2.2	8	3.9	7
ROV multipurpose	1.7	6	16.0	29
Other	0.8	3	3.9	7
Not answered	0.8	3	1.1	2

Data reported as percentage (%) and absolute values

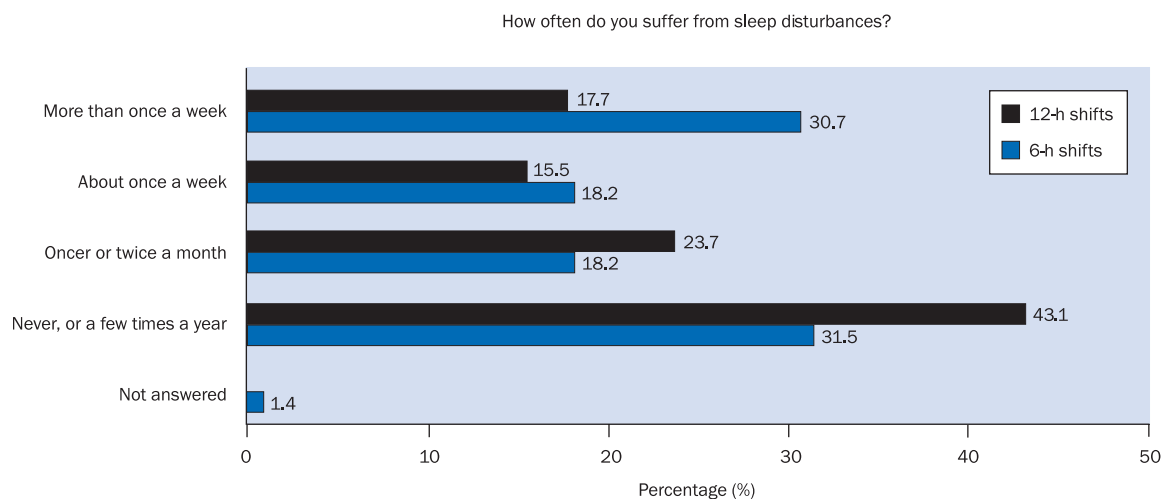


Figure 2. Sleep disturbances among 6-h shift workers (N = 362) and 12-h shift workers (N = 181). The results were significant at $p < 0.01$

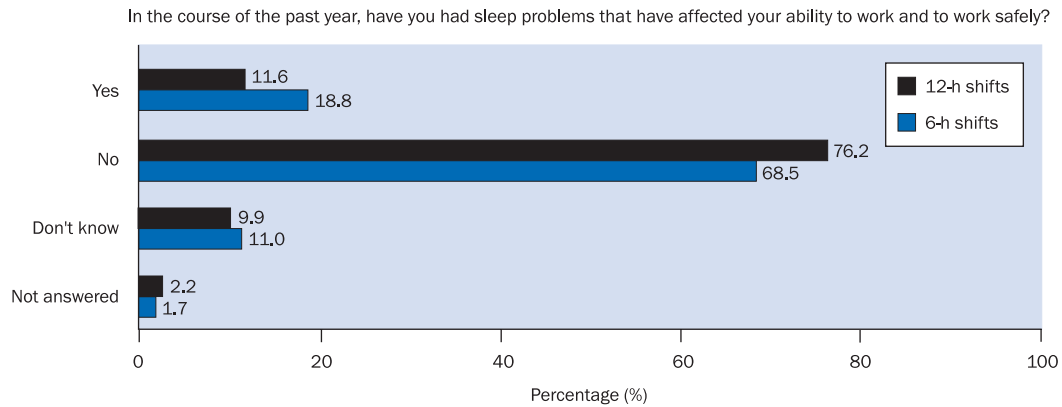


Figure 3. Work capability and safety at work among 6-h (N = 362) and 12-h (N = 181) shift workers

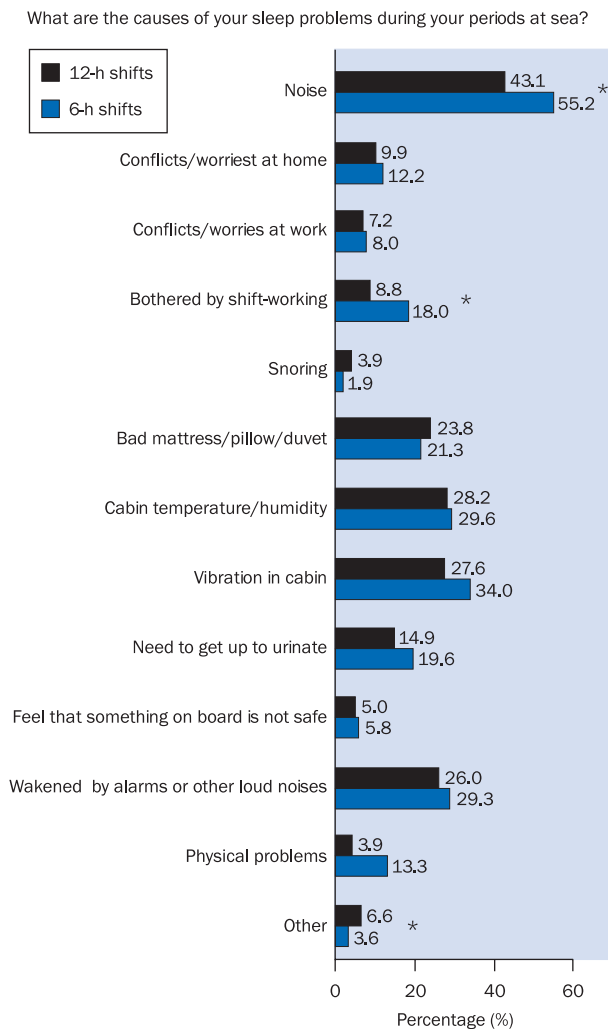


Figure 4. Causes of sleep problems. Reported in percentage within each type of shift; *p < 0.05

dies showed that changes in the shift length from 8 hours to 12 hours resulted in an improvement in

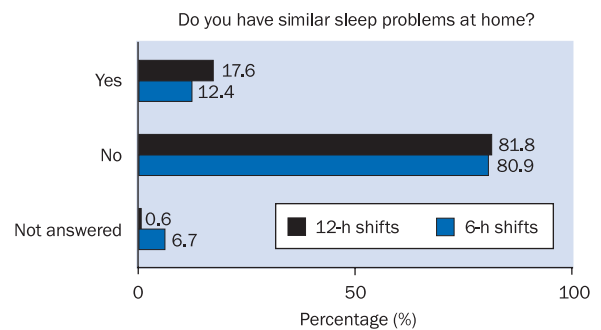


Figure 5. Sleep problems at home in 6-h shift workers (N = 362) and 12-h shift workers (N = 181)

sleep problems, sleep patterns, and subjective alertness [15, 16]. The continuity of sleep has previously been suggested as one of the most important factors for sleep quality [17], and this seems a likely factor for the sleep disturbances in the present study.

WORK CAPABILITY AND SAFETY AT WORK

Neither the 6-hour nor the 12-hour shift workers considered safety as being comprised by the sleep disturbances. Workers in the offshore fleet are governed by certain selection criteria, not only from the naval doctor examination, but also there is a certain “rough” attitude amongst these workers. This is probably a culture that is widespread in sailors, and Houtman et al. [18] suggested that admitting to fatigue and to reporting their safety concerns are lacking in sailors. A similar finding was made by Bye & Lamvik, who found that a correlation between formal risk estimation and subjective perception does not always exist [19]. Thus, what is perceived by the respondents with regard to safety is not necessarily reflected in what is known to from shift work and the effects on human physiology.

Table 2. Regional differences in sleep disturbances

	6-hours shift workers					12-hours shift workers					
	North Sea	Africa	South America	Far East	Australia	North Sea	Africa	South America	Far East	Australia	
	(n = 224)	(n = 20)	(n = 81)	(n = 6)	(n = 26)	(n = 80)	(n = 11)	(n = 55)	(n=6)	(n=28)	
How often do you suffer from sleep disturbances?	p < 0.01					p < 0.01					
More than once a week	32.6	14.3	18.5	28.6	61.5	15.0	36.4	9.1	16.7	46.4	
About once a week	20.5	19.0	11.1	14.3	23.1	10.0	18.2	16.4	0.0	25.0	
Once or twice a month	16.5	19.0	27.2	14.3	7.7	30.0	45.5	23.6	33.3	7.1	
Never, or a few times a year	30.4	42.9	40.7	28.6	7.7	45.0	0.0	50.9	50.0	21.4	
Not answered	0.0	4.8	2.5	14.3	0.0						
In the course of the past year. have you had sleep problems that have affected your ability to work and to work safely?	p = 0.03					p < 0.01					
Yes	20.5	33.3	6.2	42.9	23.1	6.3		9.1	16.7	35.7	
No	65.6	57.1	86.4	28.6	61.5	82.5	81.8	81.8	66.7	50.0	
Don't know	12.5	4.8	7.4	28.6	11.5	11.3	9.1	3.6	16.7	14.3	
Not answered	1.4	4.8			3.8		9.1	5.5			
What are the causes of your sleep problems during your periods at sea?											
Noise	52.7	61.9	53.1	42.9	76.9	28.8	54.5	52.7	50.0	57.1	p = 0.02
Conflicts/worries at home	13.4	9.5	9.9	28.6	7.7	12.5	0.0	3.6	0.0	21.4	
Conflicts/worries at work	8.0	14.3	7.4	14.3	3.8	7.5	9.1	1.8	33.3	10.7	
Bothered by shift-working	19.2	19.0	12.3	14.3	26.9	12.5	9.1	5.5	0.0	7.1	
Snoring	0.9	4.8	1.2		7.7	5.0	9.1	1.8	0.0	3.6	
Bad mattress/pillow/duvet	22.3	14.3	14.8		42.3	p = 0.04	22.5	18.2	18.2	0.0	p = 0.04
Cabin temperature/humidity	35.7	28.6	12.3		38.5	p < 0.01	40.0	27.3	14.5	16.7	p = 0.04
Vibration in cabin	32.6	38.1	32.1	42.9	42.3		25.0	36.4	25.5	16.7	
Need to get up to urinate	17.0	19.0	16.0	42.9	46.2	p < 0.01	8.8	0.0	18.2	50.0	p = 0.03
Feel that something on board is not safe	5.4	9.5	3.7	0.0	22.5	p < 0.01	0.0	36.4	5.5	0.0	p = 0.01
Wakened by alarms or other loud noises	28.1	52.4	23.5	28.6	38.5		18.8	18.2	25.5	33.3	
Physical problems	3.1		6.2		3.8		5.0	0.0	0.0	33.3	p < 0.01
Other	20.1	4.8	11.1		42.3	p < 0.01	13.8	0.0	5.5	7.1	p = 0.01
Do you have similar sleep problems at home?											
Yes	11.6	9.5	11.1	14.3	26.9		18.8	9.1	16.4	16.7	
No	79.9	85.7	84.0	85.7	73.1		67.5	90.9	76.4	83.3	
Not answered	8.5	4.8	4.9				13.8		7.3	7.1	

Data reported as percentage (%)

CAUSES OF SLEEP PROBLEMS

The causes of sleep problems at sea are relatively evenly distributed (Figure 4), but noise and shift-work itself are both reported to be more of a problem in the 6-hour shift workers. Most of the workers on 6-hour shifts are engaged in work on Platform Supply Vessels (PSV), which deliver drill pipes and other supplies to oil platforms. These make frequent use of Dynamic Positioning (DP) in order to control the vessel during operations close to the oil platform. This implies using thruster stabilization which is a well-known source of noise onboard and this might explain why noise is a problem for 6-hour shift workers. Our hypothesis is supported by the fact that 18.0% of the 6-hour shift workers report that shift-work itself is a cause of the sleep problems. It should be noted that 12-hour shift workers in fact score higher on “other” causes of sleep disturbances. What these might be is not known, but it shows that some individuals on 12-hour shifts suffer from causes not included in the questionnaire.

SLEEP PROBLEMS AT HOME

Sleep problems at home was reported by less than 20% in both groups (Figure 5) and thus the sleep problems seem to be unique for the working environment offshore. This is a quality assurance of the fact that the sleep disturbances investigated in this study are primarily caused by the working environment on the offshore vessels.

REGIONAL DIFFERENCES IN SLEEP DISTURBANCES

To investigate regional differences in seafarers is a challenge due to under-reporting and differences in safety culture [20]. Studies have found large regional differences even between countries in northern Europe. For example, when comparing seafarers to shore-based industries in the respective countries, the rate of accidents were 24-times higher in the merchant fleet in Great Britain [21], 11-times higher for the Danish merchant fleet [22], and 3.7-times higher in the Norwegian merchant fleet [23]. Whether such regional differences exist also with regard to the sleep and safety parameters investigated in this paper has not previously been reported.

We have shown in Table 2 that those working 6-hour shifts in the North Sea have more sleep disturbances than do those working in Africa, South America, and the Far East. Workers in Australia report very high scores of sleep disturbances (61.5%), and it is likely that culture plays an important role. Both Norway and Australia have high standards of working environments and this might

influence the perception and satisfaction with the work environment. The 12-hour shift workers in the North Sea are only affected to a minor degree by sleep disturbances, but it is interesting that Australia scored relatively highly (46.4%) compared to the other regional areas.

There was also a regional difference in how sleep disturbances affected safety, with very low scores in South America, but high scores in the Far East. In both 6-hour shifts and 12-hour shifts the causes of sleep problems show regional differences in many of the same parameters, i.e. bad mattress/pillow/duvet, cabin temperature/humidity, and the need to get up to urinate. Weather conditions may play a role in the scoring of cabin temperature/humidity where both 6-hour shifts and 12-hour shifts showed lower scores in warmer climates such as Africa, South America, and the Far East. These workers are probably used to warmer climates and thus are not as affected by this as those working in the North Sea in colder climates. Noise shows regional differences in the 12-hour shift workers, with those working in the North Sea scoring very low. This could in fact be why 12-hour shifts are so popular in the Norwegian offshore fleet.

It should be noted that the low number of subjects in Africa and the Far East biased the results and made direct comparisons with workers in the North Sea difficult. This might have affected the results. On the other hand, the strength of the study was that we obtained international comparable data of sleep disturbances with a reasonable sample size, which has not been performed on offshore fleet workers before.

PERSPECTIVES

Twelve-hour shifts seems to be a better solution, and the data in the present study supports this. The main concerns regarding 12-hour shifts are the effects on safety and fatigue due to the long working hours [24], and the relative accident risk in mixed occupational settings seems to increase from the 8th hour in an exponential fashion [9]. If productivity or operational activity is reduced this is likely to mitigate the effects of long work hours, but from the present analysis this cannot be determined.

Both 6-hour and 12-hour shifts on offshore vessels require further research. Most data are based on subjective statements and questionnaires, and it is necessary to obtain more specific data about objective and subjective sleep quality. This will enable researchers to specifically compare not only within the offshore sector, but also with other occupations running similar work schedules. Oilrigs have been thoroughly investigated on objective, subjective, and phy-

siological measures of adaptation rates [10-12, 25, 26]. Such data are lacking from offshore vessels.

CONCLUSIONS

In conclusion, offshore workers on the 6-hour shift suffer more from sleep disturbances than do those on 12-hour shifts. This is, however, not reflected in the individual workers perception of safety onboard, which might be due to the work culture and certain attitudes by offshore workers. The causes of sleep problems are largely the same for those working 6-hour shifts and those working 12-hour shifts, although noise and the shift-work itself is worse among 6-hour shift workers. The offshore conditions combined with shift-work are the main cause of sleep disturbances, since the same problems are not experienced when residing at home.

There are regional differences in sleep disturbances, safety concerns, and causes of sleep problems. Safety culture, work morale, and weather conditions, between regions and continents, are likely to influence the perception of sleep disturbances, safety onboard, and causes of sleep problems.

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The authors declare that they have no conflict of interest.

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