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Shift work and age in the offshore petroleum industry

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ABSTRACT

Background. *Shift work is associated with sleep and health problems. Tolerance to shift work is reported to decrease with age. Shift work tolerance should be considered in different shift work populations. The aim of the study was to examine the relationship between age, shift work exposure, shift type, and morningness and sleep/health problems in oil rig shift workers.*

Material and methods. *A total of 199 workers participated. They worked either two weeks of 12-h day shifts (n = 96) or two weeks of swing shifts (n = 103) (one week of 12-h night shifts followed by one week of 12-h day shifts), followed by four weeks off work. The workers filled out questionnaires on demographics, work, sleep, and health.*

Results. *We found no significant associations between age or years of shift work exposure and any of the sleep, sleepiness, or health parameters. There was a significant association between shift type and sleep duration, showing that swing shift workers had longer sleep duration than day shift workers. In addition, we found a significant association between the interaction age*, shift type, and sleep duration, where sleep duration was negatively associated with age for the swing shift workers and positively associated with age for the day shift workers. There were significant associations between morningness and sleep latency, sleep efficiency, and insomnia.*

Conclusions. *Older workers may tolerate shift work well. Age, shift work exposure time, and shift type seemed not to affect shift work tolerance in this population. However, this may be due to a healthy worker effect and/or selection bias.*

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Key words: ageing, morningness, health, shift work, shift work tolerance

INTRODUCTION

A variety of adverse biological, psychological, and social effects of shift work, and night work in particular, have been reported in the literature. Sleep disturbances, manifested as insomnia, shortened sleep duration, and sleepiness are among the most commonly reported complaints [1, 2]. Gastrointestinal symptoms, musculoskeletal symptoms, and fatigue have also been reported more frequently by shift workers than day workers [3–5].

Increased age in the general population and a delayed retirement age combined with social trends towards a 24-hour society are expected to lead to a higher number of older shift workers [6]. In some industries, as in the offshore petroleum industry, most employees have some kind of shift schedule. There is little research directed specifically at the offshore industry concerning the different health effects of shift work [7]. The work schedules vary between operators, platforms, and type of work performed [7]. The most frequently used work pattern in the Norwegian offshore oil industry consists of two weeks of work followed by four weeks off work, and the shift schedules used vary between day and

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night shift. The lengths of the shifts are normally twelve hours.

The work force in the offshore petroleum industry is gradually ageing [7]. The mean age in the Norwegian offshore industry increased from 39 to 43 years from 1992 to 2003. This has raised interest about whether older workers tolerate shift work or not. Studies on ageing and shift work show conflicting results. The majority of studies on this topic conclude that tolerance to shift work decreases with age, and that increasing age is associated with increasing negative health effects of shift work [8, 9]. The critical age for reduced tolerance to shift and night work is reported to be between 40 and 50 years [6, 8]. The supposed increased vulnerability of ageing workers to the negative effects of shift and night work may be related to circadian factors and reduced sleep duration with subsequent sleepiness as well as to social factors and working conditions [6]. Ageing is associated with a decreased ability for circadian adjustment and with increased sleep disturbances [8]. The difference in circadian phase position between individuals, characterized as morning versus evening types, is also believed to influence tolerance to night work, with morning types being less tolerant to night shift work [10, 11]. Ageing is normally associated with earlier phasing (morningness), due to both shortening of the normal circadian rhythm and reduced sleep duration [6].

Still, some have argued that old age may be associated with better adaptation to night work. As proposed by Harrington [12] shift work could be better tolerated with older age because of less domestic pressures from small children, more experience with coping in general, and because older people seem to require less sleep than younger people. Younger people can find it more difficult to adapt to night work due to higher sensitivity to acute sleep loss than older people and because shift work hampers the possibility to participate and integrate in social life [2]. Findings indicating that the negative health effects of shift work seem to increase with age might also be explained by other factors than age per se, such as total shift work exposure. Previous studies suggest that former shift workers of every age report more sleep disturbances than day workers, but fewer problems than present shift workers [13, 14].

Due to the conflicting view on how age is related to shift work tolerance, further studies are needed in different shift work populations and in groups with different work schedules. This study is, to our knowledge, the first to investigate how different sleep and health parameters relate to age, shift work exposure, and morningness in the same workers. Our hypothesis was that sleep and health problems in relation to shift work were related to age, but also to other factors such as years with shift work, shift type, and morningness.

MATERIAL AND METHODS

This cross-sectional study was performed at a Norwegian oil rig in the North Sea. A total of 259 workers were invited to participate. In all, 204 workers (197 men, 7 women) agreed, yielding a response rate of 79%. Five workers were excluded from the analyses due to missing data. The questionnaires were completed during the first workday at the oil rig. The workers in the present study worked either a 12-h day shift or swing shift depending on work tasks. This comprised 14 days of 12-h day shift (0700 hrs — 1900 hrs) for the day shift workers (n = 96) and a swing shift pattern consisting of one week of 12-h night shift (1900 hrs — 0700 hrs) followed immediately by one week of 12-h day shift for the swing shift workers (n = = 103). On the "swing" day, the night shift ended at 0400 hrs with a 6-h break before the day shift began at 1000 hrs and lasted until 1900 hrs. Nearly all workers (98%) worked either with production or drilling. Other data from this study population have recently been published elsewhere [15].

The questionnaire included items measuring demographic variables (age, sex, marital status), working conditions (position, functions, employment), shift schedule (day shift or swing shift), and work experience (years of work experience offshore). Shift work exposure was defined as number of years with offshore work.

Sleep was measured by the Pittsburgh Sleep Quality Index (PSQI). This instrument assesses quality of sleep and identifies sleep complaints during the last month [16].

Insomnia was measured by the Bergen Insomnia Scale (BIS), which consists of six items adhering to criteria for insomnia stated in the Diagnostic and Statistical Manual for Mental Disorders (DSM-IV, American Psychiatric Association, 2000) and conforming to clinical criteria for defining insomnia [17].

Sleepiness was measured by the Epworth Sleepiness Scale (ESS) [18]. The ESS comprises eight items that measure general tendency to sleep or doze off in eight different situations.

Circadian preference was measured by the Composite Morningness Questionnaire (CMQ) [19].

Subjective health complaints were measured by the Subjective Health Complaint Inventory (SHC) [20].

Table 1. Demographic variables in three age groups of oil rig workers

	Workers 19–35 years (n = 52)	Workers 36–50 years (n = 92)	Workers 51–62 years (n = 55)
Mean age in years (SD)	28.9 (4.6)	43.5 (4.7)	55.1 (2.6)
Mean years with offshore work (SD)	6.4 (3.5)	16.9 (7.5)	23.9 (5.5)
Shift schedule %, (n)	29% (15) day work	46% (42) day work	71% (39) day work
	71% (37) swing shift work	54% (50) swing shift work	29% (16) swing shift work

The SHC consists of 29 items measuring subjective somatic and psychological complaints experienced within the last 30 days. The items are summarized to a total sum score and five separate sum scores.

The study protocol was approved by the Regional Ethics Committee for Medical and Health Research Ethics, Western Norway (REK-West) and the Norwegian Social Science Data Services (NSD).

Multiple linear regressions were conducted to assess the relationship between age, shift work exposure, circadian preference, shift type, and the different outcome measures of sleep and health. Preliminary analyses were conducted to ensure no violation of the assumptions of normality, linearity, multicollinearity, and homoscedasticity. The variable sleep latency was not normally distributed (positive skewed) and was therefore log transformed. We computed a new centred age variable by subtracting the mean score from each single data-point on the age variable. The centred age-variable was used in all analyses. In order to investigate whether age or morningness were moderators for the relationship between shift work and different health outcomes a shift x age interaction term and a shift x morningness interaction term were also included as predictors in the analyses. Hence, six predictors were used in the linear regression analyses, and all predictors were entered in the analyses. The 12-h day shift was set as value 0 and the swing shift as value 1. In order to explore potential significant interaction effects between predictor variables (?), a post hoc probe procedure as described by Holmbeck was used [21]. In the case of significant interaction effects, figures for the ease of interpretation of such effects were made [21]. In addition, for comparison of younger and older workers we divided the workers into three different age groups: younger than 35 years, 36 to 50 years, and 51 years and older. The three age groups were subsequently compared using one-way ANOVAs with least significance difference (LSD) post hoc tests. All data analyses were performed using SPSS version 15.0 for Windows, and the significance level was set to 0.05.

RESULTS

The mean age was 42.9 years (± 10.5, range 19–62 years). The mean work exposure offshore was 16.1 years (± 8.9, range 0.5–37 years). Eighty-one per cent of the workers described their health as very good or good, and mean BMI was 26 (range 19–37). Table 1 shows the demographic variables in the three different age groups.

We found few significant associations with age, shift work exposure, shift type, morningness, the two interaction terms and the different sleep parameters (measured by PSQI, BIS and ESS) and health (measured by SHC) using linear regression analysis (Table 2). For the PSQI global score the six predictors explained 3% of the variance $F(6, 171) = 0.87$, $p = 0.52$. None of the predictors were significantly associated to the PSQI global score (Table 2). For the PSQI sleep latency score the six predictors explained 7% of the variance $F(6, 181) = 2.31$, $p = 0.04$. The morningness-score was significantly and negatively associated with the PSQI sleep latency score (see Table 2). For the PSQI sleep efficiency score the six predictors explained 4% of the variance $F(6, 179) = 1.30$, $p = 0.26$. The morningness-score was significantly and positively associated with the PSQI sleep efficiency score (Table 2). For the PSQI sleep duration the six predictors explained 18% of the variance $F(6, 180) = 6.64$, $p = 0.001$. Shift type (0 = day shift, 1= swing shift) was significantly and positively associated with the PSQI sleep duration score. The interaction “shift x age” was significantly associated with the PSQI sleep duration score (Table 2). The post hoc probing of the significant interaction effect for sleep duration is presented in Figure 1, showing that sleep duration was negatively associated with age for the swing shift workers and positively associated with age for the day shift workers. For the BIS score the six predictors explained 5% of the variance $F(6, 176) = 1.54$, $p = 0.17$. The morningness score was significantly and negatively associated with the BIS score (Table 2). For the ESS score the six predictors

Table 2. Sleep and health parameters and associations with age, shift work exposure, shift type, morningness, and interaction terms in 199 oil rig workers using linear regression analysis

Variables	Beta coeff.	P-value
Pittsburgh Sleep Quality Index (PSQI)		
Age	0.004	0.98
Shift work exposure	0.08	0.53
Shift type (0 = day shift, 1 = swing shift)	0.02	0.79
Age *shift	0.02	0.84
Morningness (CMQ)	–0.23	0.06
Morningness *shift	0.18	0.13
Sleep latency		
Age	–0.08	0.58
Shift work exposure	0.08	0.52
Shift type (0 = day shift, 1 = swing shift)	–0.11	0.16
Age *shift	0.04	0.71
Morningness (CMQ)	–0.25	0.03*
Morningness *shift	0.01	0.92
Sleep efficiency		
Age	0.16	0.28
Shift work exposure	–0.09	0.49
Shift type (0 = day shift, 1 = swing shift)	–0.08	0.32
Age *shift	–0.04	0.72
Morningness (CMQ)	0.23	0.05*
Morningness *shift	–0.18	0.12
Sleep duration		
Age	0.15	0.27
Shift work exposure	–0.09	0.46
Shift type (0 = day shift, 1 = swing shift)	0.18	0.01*
Age *shift	–0.21	0.04*
Morningness (CMQ)	–0.14	0.20
Morningness *shift	–0.18	0.09
Bergen Insomnia Scale		
Age	–0.12	0.44
Shift work exposure	0.23	0.08
Shift type (0 = day shift, 1 = swing shift)	–0.01	0.88
Age *shift	0.04	0.72
Morningness (CMQ)	–0.24	0.04*
Morningness *shift	0.17	0.14
Epworth Sleepiness Scale		
Age	–0.10	0.51
Shift work exposure	0.14	0.29
Shift type (0 = day shift, 1 = swing shift)	–0.06	0.43
Age *shift	0.05	0.68
Morningness (CMQ)	–0.04	0.75
Morningness *shift	–0.08	0.51
Subjective Health Complaints		
Age	0.03	0.86
Shift work exposure	0.19	0.14
Shift type (0 = day shift, 1 = swing shift)	0.09	0.25
Age *shift	0.001	0.99
Morningness (CMQ)	–0.15	0.18
Morningness *shift	0.05	0.64

*Statistically significant, $p < 0.05$

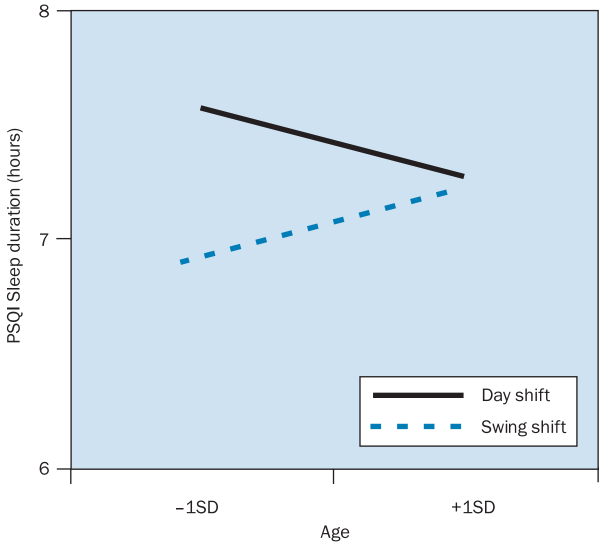

Figure 1. The predicted sleep duration for subjects scoring one standard deviation below mean age and subjects scoring one standard deviation above mean age for the two shift types (day shift and swing shift)

explained 2% of the variance F(6, 180) = 0.70, p = = 0.65. None of the predictors were significantly associated with the ESS score (Table 2). For the SHC total score the six predictors explained 5% of the variance F(6, 183) = 1.59, p = 0.15. None of the predictors were significantly associated with the SHC total score (Table 2).

The older workers reported shorter sleep duration, more morningness, and more musculoskeletal complaints than the younger workers when comparing the three different age groups (Table 3) using one-way ANOVA. Otherwise, we found no significant differences between the groups in terms of PSQI global score, calculated sleep latency or sleep efficiency (data extracted from PSQI), total insomnia score (measured by BIS), sleepiness (measured by ESS), or subjective health complaints (measured by SHC).

DISCUSSION

In this group of offshore oil rig workers, age was not associated with sleep, sleepiness, or health. There was a significant association between shift type (day shift and swing shift) and sleep duration, where swing shift workers reported longer sleep duration than day shift workers. There was also a significant association between the interaction age x shift type and sleep duration, showing that sleep duration was negatively associated with age in the group of swing shift workers and positively associated with age in the group of day shift workers. In addition, workers scoring highly on morningness reported shorter sleep latency, higher sleep efficiency, and less complaints of insomnia.

There are large inter-individual differences in tolerance to shift work [22], and ageing has been one of the most cited factors related to impaired shift work tolerance [23]. Several studies indicate that sleep problems related to shift work increase with age [13, 23], the critical age seems to be about 40–50 years [23]. Shift workers above 40–50 years of age report feeling worse after night shifts than their younger counterparts, and sleepiness after successive night shifts also increase with age [23]. In the offshore industry it is claimed that there is a linear relationship between age and health, and that health problems arise due to a combination of both high age and long offshore exposure [24]. Thus far, data show that time spent offshore makes a higher contribution to health complaints, especially to musculoskeletal complaints, than age [24]. In the present study, however, we found no associations between age and shift work exposure on the one hand and global sleep parameters such as sleep quality, insomnia, or sleepiness on the other. In our group of workers, the oldest workers reported significantly more musculoskeletal complaints than the two younger groups, but not higher levels of health complaints in general. Thus, the older workers seemed to tolerate shift work fairly well in terms of sleep and health, both in the group of swing shift workers and in the 12-h day shift worker group.

The results from the present study may be due to a selection bias denoted as the “healthy worker effect”. The “healthy worker effect” implies that unhealthy individuals are being excluded from, or quit, shift work, whereas healthy individuals are more likely to be selected for, and remain in, shift work [25]. In addition, the offshore industry has strict regulations regarding health and use of medication. All employees need an offshore medical health certificate and are examined by a physician every other year for a certificate renewal. A large number of disorders are not compatible with renewal of the health certificate, and in such cases the workers are no longer allowed to work offshore.

As proposed by Harrington (2001), shift work tolerance may improve with age, due to less domestic demands, improved coping skills, and reduced sleep need, which all seem to favour the older shift worker [12]. Younger people may be more sensitive to acute sleep loss than older people are [2]. The results from our study are in accordance with findings from a Canadian study on petroleum refinery workers that

Table 3. Sleep, sleepiness, and health in three age groups of oil rig workers using one-way ANOVA analyses

Outcome variable	Workers 19–35 yrs Mean (SD)	Workers 36–50 yrs Mean (SD)	Workers 51–62 Mean (SD)	P-value
PSQI global score	4.64 (2.45)	4.22 (2.49)	4.98 (3.07)	0.24
PSQI, sleep latency in min.	18.84 (18.86)	15.54 (10.44)	16.98 (12.79)	0.38
PSQI, sleep efficiency in %	85.95 (10.03)	89.54 (8.42)	88.80 (10.50)	0.09
PSQI, sleep length in hours	7.60 (1.02)	7.21 (0.87)	7.18 (1.03)	0.04*
BIS total score	7.36 (6.05)	7.09 (6.30)	8.54 (7.37)	0.42
ESS	6.60 (2.97)	6.99 (3.81)	6.64 (3.83)	0.77
CMQ sum score	35.74 (5.36)	37.90 (5.19)	38.84 (5.23)	0.008**
SHC total score	6.47 (5.24)	6.90 (5.71)	7.94 (7.53)	0.43
SHC musculoskeletal	1.71 (5.61)	5.11 (16.76)	16.93 (45.19)	0.008**
SHC pseudoneurology	1.63 (4.49)	0.97 (3.43)	1.61 (4.34)	0.53
SHC gastrointestinal	1.50 (6.15)	1.24 (4.86)	1.35 (6.10)	0.97
SHC allergy	0.35 (1.54)	0.65 (2.43)	0.79 (3.06)	0.65
SHC flu	0.79 (2.29)	0.37 (1.18	1.07 (3.86)	0.23

*$p < 0.05$; **$p < 0.001$; PSQI — Pittsburgh Sleep Quality Index; BIS — Bergen Insomnia Scale; ESS — Epworth Sleepiness Scale; CMQ — Composite Morningness Questionnaire; SHC — Subjective Health Complaint Inventory

reported no significant differences regarding sleep or fatigue between younger and older workers [26]. In addition to the healthy worker effect and other kinds of selection mentioned earlier, it is described that primarily the eldest part of the work force is selected to executive positions, which normally involve day work only [24]. Also in our study, in the group of younger workers there were far more swing shift workers than day shift workers, whereas the opposite was true in the group of workers older than 50. Shift work preference and self-selection of employees may be important factors for health and acceptance of odd and inconvenient work hours. Studies of shift work tolerance have found that satisfaction with the shift schedule seems to reflect how well the shift workers cope with it. It is suggested that an increase in sleep/wake problems for dissatisfied shift workers is related to increased sensitivity to curtailed and displaced sleep [27]. Some people choose to work shift due to social or financial benefits of such work hours. The most obvious benefit of compressed work hours is long periods off work. Work within the offshore industry in Norway is considered well paid and has the benefit of long periods off work (4 weeks off for every 2 weeks at work). This may contribute to coping with such shift schedules. In accordance with this, a study by Di Milia (1998) found that many shift workers rated leisure time higher than the negative effect of shift work disturbances [28].

Morningness implies an advanced circadian rhythm of sleep-wakefulness and activity [23], and has been found to be related to a decreased tolerance to shift work [29]. In our group of workers there were more morning types in the group of older workers than in the group of younger workers. Of the six predictors in the multiple linear regression analyses, morningness was the one predictor that made the greatest unique contribution in terms of explaining variance in the outcome variables. Morningness was associated with shorter sleep latency, increased sleep efficiency, and a lower score for insomnia. Thus, morningness was associated with improved shift work tolerance in accordance with some studies [30] but contrary to other studies [31].

The strength of the current study was that all subjects were working and living under similar conditions, without interfering factors such as domestic and social demands. In these terms the study is comparable to laboratory-studies.

The present study has some limitations, which should be noted. Firstly, we did not include objective measures of sleep or sleepiness such as actigraphy, or performance tests. Hence, all results are based on self-reports only, making the results vulnerable to the common method variance bias [32]. Neither did we include any measures of objective health, such as blood pressure or blood parameters, but due to biannually health screening we can assume that the workers were healthy and that the use of medication was limited. Secondly, our findings are furthermore limited to a relatively small sample size working in a controlled and confined shift work environment. Thus the results may not be generalized to other working conditions or populations without some reservations. Still, the results from our study do indicate that many older workers seem to cope well with shift work. Longitudinal studies will give a substantial and additional contribution to further knowledge in shift work research and should therefore be emphasized in future research.

In conclusion, this study shows that older workers may tolerate shift work well. Age, shift work exposure, and shift type seemed not to affect the tolerance to shift work much in this population. This may result from different kinds of selection bias, but may also be due to other factors contributing to shift work tolerance.

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