

The Relationship between Sleep Characteristics and Workplace Accidents

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Abstract

Background and Objective: Sleep problems in industries can influence workers' health. Shift work and its associated sleep problems are quite common among workers in different industries. The aim of this study was to assess sleep quality, insomnia, excessive daytime sleepiness (EDS), and obstructive sleep apnea (OSA) in workers of an automobile factory.

Materials and Methods: This cross-sectional study was conducted during annual periodic examination of workers from a production unit of an automobile factory. A total of 522 workers filled in questionnaires including demographic characteristics, workplace accidents, Pittsburgh Sleep Quality Index (PSQI), Insomnia Severity Index (ISI), Epworth Sleepiness Scale (ESS), and STOP-BANG [snoring, tiredness, observed stop of breathing in sleep, blood pressure, body mass index (BMI), age, neck circumference, gender]. T-test and descriptive statistics were used for data analysis.

Results: The participants had mean and standard deviation (SD) age of 37.24 ± 5.73 years. Of 522 participants, 65.3%, 14.4%, and 3.3% had PSQI ≥ 5 , ESS ≥ 13 , and STOP-BANG ≥ 4 , respectively. Higher scores of PSQI and ISI were associated with significant increase of workplace accidents ($P = 0.010$ and $P = 0.004$, respectively). Moreover, participants with rotational shift work significantly had more ISI than the ones with fixed shift work.

Conclusion: Poor sleep quality and insomnia were prevalent among studied workers with shift work. Sleep problems also had significant association with workplace accidents. This finding warrants more attention towards shift schedules of the workers and further investigation and management of identified sleep problems.

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Keywords: Shift work schedule; Occupational accidents; Sleep

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Introduction

Sleep disorders may be considered as one of the most common health problems. Up to one third of general population is reported to suffer from one kind of insomnia depending on the methodology used for definition of the disease (1, 2). Poor sleep quality has been reported in 37% of adult population of Tehran City, Iran (3). The prevalence of obstructive sleep apnea (OSA) syndrome, the other common sleep problem in population, has been estimated as 20% (4).

Quality and also duration of sleep has an important impact on health. Sleep disturbance could have several adverse consequences on health including fatigue, anxiety, poor concentration, decreased quality of life, and even impaired cell repair (4).

Sleep problems in industries can influence workers' health individually. Furthermore, due to the health consequences of sleep problems several organizational problems could arise. Increased health costs, increased days of sick leave, decreased workers' motivation and productivity, and increased incidence of workplace accidents are among the reported occupational adverse impacts of sleep problems in the workplace (4). Workers' excessive sleepiness, especially during night shifts, may lead to decreased function of workers

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that could endanger workers' health and safety or lead to more motor vehicle accidents (MVAs) (5).

Shift work is defined as working out of usual hours of work (9 AM to 5 PM). Along with development of industries' shift working, it is estimated that 15% to 30% of US workers are shift workers (5). Shift working is more prevalent in developing countries such as Iran due to the organizational problems (4). Shiftwork is reported to have significant impact on workers' sleep quality and duration. Linton et al., in a systematic review of workplace influence on workers' sleep, have indicated an association between shift work and incidence of future sleep problems (6).

Ample of evidence is also available regarding poor sleep quality in occupational settings. For instance, Mokarami et al. have showed poor sleep quality in half of the shift workers of a press industry, with significant association between sleep quality and general health (7).

International Classification of Sleep Disorders II (ICSD-2) defines shift work sleep disorder (SWSD) as insomnia or excessive sleepiness in association with working schedule that disturbs individual's sleep (8). Previous reports have indicated SWSD in 32% of night shift workers (9-11), 10% of morning or evening shift workers (10), and 8% to 26% of rotational shift workers (11).

Shift working is also associated with several health problems including cardiovascular disorders, dysregulated glucose and lipid metabolism, gastrointestinal (GI) problems, infertility, and breast cancer. The health effects of shift work are speculated to be due to dysregulation of biologic body rhythms including circadian rhythm, depth of sleep, and fatigue (12). Annual incidence of occupational accidents is 337 million among which 360000 lead to death. Annual economic burden of workplace accidents is estimated to be 2880 billion dollars in US (2). In Iran, Mohammadfam et al. have estimated that more than 777 billion rials is lost because of deaths related to workplace accidents (13). Mehrparvar et al., in another study, indicated that 10.8% of deaths in a period of two years in Yazd City, Iran, were due to occupational accidents (14).

One report in 2002 showed that rotational day-shift workers had two-fold increase in workplace accidents in comparison with fixed dayshift workers. Furthermore, Ohayon et al. reported more days of sick leave among rotational dayshift workers and night shift workers (15). Uehli, in a

systematic review in 2012, has reported 1.62 times higher risk for workplace accidents among workers with sleep problems (2). Hassani et al., in a study of occupational accidents among health care workers of a hospital, observed more risk of workplace accidents [odds ratio (OR): 2.73] in workers who were at high risk of sleep apnea (16).

Up to our knowledge, limited evidence is available in Iran regarding association of workplace accidents and sleep disorders. This study aimed to assess sleep quality, insomnia, excessive sleepiness, and sleep apnea in workers of an automobile factory. Association of sleep problems with shift work and workplace accidents were also evaluated.

Materials and Methods

This cross-sectional study was conducted in a production unit of an automobile factory. Participants were employed workers with at least 5 years of work experience referred for periodic annual examination to an educational occupational health clinic in Tehran City. Written consent form was obtained from all study participants. The study was approved by Ethical Committee of Tehran University of Medical Sciences.

A total of 522 workers with aforementioned inclusion criteria were enrolled in this study using convenience sampling method. Workers with neurologic or psychological problems affecting sleep and those who were taking sleep medications were excluded from the study.

At first, purpose of the study was explained to the participants. A questionnaire including demographic information, anthropometric data, sex, age, marital status, educational level, years of experience in the factory, and number of children was completed for all participants. Occupational characteristics comprising shift work type (fixed or rotational) and workplace accidents were also asked. We assessed participants' sleep characteristics using validated questionnaires including Insomnia Severity Index (ISI), Epworth Sleepiness Scale (ESS), STOP-BANG [snoring, tiredness, observed stop of breathing in sleep, blood pressure, body mass index (BMI), age, neck circumference, gender], and Pittsburgh Sleep Quality Index (PSQI).

STOP-BANG questionnaire was used for assessing risk of sleep apnea. First part of the questionnaire asks about snoring, tiredness, observed stop of breathing in sleep, and blood pressure. One score is assigned to each question with posi-

tive response. Second part, which is more objective, consists of BMI, neck circumference, and gender. Male gender, neck circumference > 40 cm, age > 50 years, and BMI > 35 kg/m² have one score in 2nd part. For the purpose of this study, score of 4 or more in both parts was considered as high risk for sleep apnea. Sadeghniaat-Haghighi et al. validated the Persian version of the questionnaire (17).

ESS evaluates excessive daytime sleepiness in different situations through eight questions, each of which having four scores. Each question scores sleepiness from 0 to 3 (no sleepiness to high probable napping during sitting and reading, watching TV, sitting without activity in a public place, sitting in automobile as passenger, lying down afternoon, speaking with somebody, after lunch, and in a vehicle in traffic). ESS score more than 13 was considered as severe sleepiness in this study. The Persian version is also validated in Iran (18).

ISI questionnaire evaluates different types of insomnia during past two weeks. ISI consists of seven items with scores from 0-4 validated by Yazdi et al. (19).

PSQI assesses sleep quality of adults in the past two months. PSQI includes 19 questions evaluating sleep in seven components (sleep quality, sleep onset, sleep duration, sleep habits, sleep disorders, using medication, and daily dysfunction). Total score ranges from 0-21. The respondents with PSQI > 5 are considered to have poor sleep quality (19). Collected data were analyzed using descriptive statistics and chi-square test for categorical variables and t-test for quantitative variables. SPSS software (version 17, SPSS Inc., Chicago, IL, USA) was used for statistical analysis. P-value < 0.05 was considered statistically significant.

Results

A total of 522 participants were recruited in the current study with mean and SD age of 37.2 ± 5.7 years. Mean and SD of workers' experience was 13.2 ± 4.6 years. 65.1% were rotational shift workers. 22.6% of them reported accidents at the workplace. Descriptive characteristics of the study participants are presented in table 1.

Table 1. Participants' demographic and occupational characteristics (n = 522)

Characteristic	Category	Mean (SD)
Age (year)		37.2 (5.7)
Working experience (year)		13.2 (4.6)
BMI (kg/m ²)		26.8 (4.2)
		Frequency (percent)
Marital Status	Single	32 (6.1)
	Married	490 (93.9)
Shiftwork	Fixed	182 (34.9)
	Rotational	340 (65.1)
Educational level	Diploma	278 (53.3)
	Upper diploma	244 (46.7)
Workplace accident	Yes	118 (22.6)
	No	403 (77.3)

BMI: Body mass index; SD: Standard deviation

As presented in table 2, mean and SD of PSQI score in this study was 6.1 ± 3.3. Findings indicated that 65.3% of the workers had poor sleep quality (PSQI ≥ 5). Participants who reported more sleep problems in PSQI and ISI questionnaires had history of workplace accidents with significant statistical association (Table 3). The workers older than 35 years had better sleep quality. However, sleep quality was not significantly associated with years of work experience (Table 4).

Table 2. PSQI, ESS, STOP-BANG, and ISI scores of study participants

Questionnaire	Mean (SD) of score	Category	Frequency (percent)
PSQI	6.1 (3.3)	< 5	181 (34.7)
		≥ 5	341 (65.3)
ESS	9.0 (5.7)	< 13	447 (85.6)
		≥ 13	75 (14.4)
STOP-BANG	7.3 (4.5)	< 4	505 (96.7)
		≥ 4	17 (3.3)
ISI	2.3 (1.0)	Not significant	228 (43.7)
		Subthreshold insomnia	198 (37.9)
		Moderate severity	84 (16.1)
		Severe	12 (2.3)

SD: Standard deviation; PSQI: Pittsburgh Sleep Quality Index; ISI: Insomnia Severity Index; ESS: Epworth Sleepiness Scale; STOP-BANG: Snoring, tiredness, observed apnea, blood pressure, body mass index (BMI), age, neck circumference, gender

Table 3. Association of PSQI score with work accidents

Questionnaire	Workplace accident	N	Mean (SD) of score	P-value
PSQI	No	404	5.87 (3.110)	0.010
	Yes	118	6.86 (3.818)	
ISI	No	404	8.67 (5.518)	0.004
	Yes	118	10.41 (6.341)	
ESS	No	404	7.26 (4.468)	0.280
	Yes	118	7.78 (4.845)	
STOP-BANG	No	403	2.35 (1.086)	0.680
	Yes	118	2.31 (0.940)	

SD: Standard deviation; PSQI: Pittsburgh Sleep Quality Index; ISI: Insomnia Severity Index; ESS: Epworth Sleepiness Scale; STOP-BANG: Snoring, tiredness, observed apnea, blood pressure, body mass index (BMI), age, neck circumference, gender

Table 4. Sleep quality in terms of age and work experience among study participants

Variable	Category	Mean (SD) of PSQI score	P-value
Age (year)	< 35	6.41 (3.517)	0.050
	≥ 35	5.85 (3.118)	
Work experience (year)	< 12	6.28 (3.379)	0.200
	≥ 12	5.91 (3.227)	

PSQI: Pittsburgh Sleep Quality Index; SD: Standard deviation

Moreover, participants with rotational shift work had significantly more ISI than the ones with fixed shiftwork (9.43 vs. 8.38, respectively; $P = 0.040$).

Participants' sleep quality did not have significant associations with their marital status or number of children. Workplace accidents found to be statistically associated with delayed sleep onset, poor sleep habits, and sleep disruption as the components of PSQI ($P = 0.007$, 0.050 , and 0.002 , respectively) (Table 5).

Table 5. Different components of PSQI in terms of workplace accidents

Variable	Category			P-value
C1: subjective sleep quality	No ^e	1.09	0.734	0.210
	Yes ^a	1.18	0.727	
C2: sleep latency	No	0.83	0.843	0.007
	Yes	1.10	0.973	
C3: sleep duration	No	1.37	0.791	0.240
	Yes	1.47	0.931	
C4: habitual sleep efficiency	No	0.28	0.594	0.050
	Yes	0.44	0.801	
C5: sleep disturbances	No	1.04	0.604	0.002
	Yes	1.37	1.977	
C6: use of sleeping medication	No	0.10	0.378	0.100
	Yes	0.20	0.620	
C7: daytime dysfunction	No	1.17	0.895	0.230
	Yes	1.28	1.062	

^eNumber of accident negative: 403; ^aNumber of accident positive: 118
PSQI: Pittsburgh Sleep Quality Index

Discussion

Current results indicated that more than half of

the investigated workers had poor sleep quality, which was quite more than the reported sleep quality in general population in Tehran City (3). The most significant characteristic of this study population was shift work that may explain the difference. However, 18.4% of the participants reported insomnia that is consistent with the results of previous studies.

Significant associations were observed between rotational shift work, poor sleep quality, insomnia severity, and workplace accidents.

Consistent with current results, Son et al. reported more poor sleep quality in night shift workers (30%) compared to day workers (20). Mokarami et al., in a press industry, reported poor sleep quality in half of the shift workers with significant association with their general health (7). In the other two studies among nurses, poor sleep quality was reported and shift work nurses were found to have more poor sleep quality with increasing number of night shifts (21, 22). However, another study by Ghalichi et al. showed lower prevalence of poor sleep quality (43%) among health care workers (23).

Sadeghniaat-Haghighi et al., in the assessment of sleep quality of truck drivers who drive long distances, indicated poor sleep quality in 50% of the studied drivers (24). Several studies report significant associations between rotational and irregular shift work with sleep problems (4, 21-24). However, Mokarami et al. did not find any statistical association between shiftwork and sleep quality (7). This study observed association between PSQI score and rotational shiftwork that was not significant, but this group of workers had more severe insomnia according to ISI. This observation may be due to subjective report of sleep quality and insomnia by the workers.

Present study showed that workplace accidents was associated with poor sleep quality and insomnia. Several components of PSQI and ISI had sig-

nificant relationship with the accidents. The findings are along with previous related studies (25-27). A study on 1891 male workers in Japan in 2010 showed a statistical association between workplace accidents and short sleep duration, subjective insufficient sleep, difficulty waking up in the morning, and long working hours (25). A systematic review regarding shiftwork also has indicated poorer health condition and more occupational errors in night shift workers (27). Poor sleep quality seems to be prevalent among studied workers and more than the general population, which needs more investigation.

Several limitations exist in the present study. Self-reporting of symptoms and the time needed for completion of multiple questionnaires during physical examination of the workers may influence the reported symptoms. More objective evaluation of participants' sleep disorders such as sleep physician visit, actigraphy, and polysomnography (PSG) in selected patients is highly recommended.

Conclusion

Poor sleep quality and insomnia were common among studied workers with shiftwork. Sleep problems also had a significant association with workplace accidents. This finding warrants more attention towards shift schedules of the workers and further investigation and management of identified sleep problems.

Conflict of Interests

Authors have no conflict of interests.

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