IJOEM
International Journal of Occupational and Environmental Medicine

Original Article

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Excessive Daytime Sleepiness and Safety Performance: Comparing Proactive and Reactive Approaches

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Abstract

Background: Sleep disorders and excessive daytime sleepiness negatively affect employees' safety performance.

Objective: To investigate the relationship between excessive daytime sleepiness with obstructive sleep apnea and safety performance at an oil construction company in Iran.

Methods: 661 employees consented to participate in this study. Excessive daytime sleepiness was measured with the STOP-BANG questionnaire and Epworth Sleepiness Scale (ESS). To determine how sleepiness would affect the studied occupational incidents, accidents causing injury and near misses, both reactive data and proactive safety performance indices were measured. Demographic and predictor variables were analyzed with hierarchical multiple linear regression.

Results: Employees who met the criteria of excessive daytime sleepiness and obstructive sleep apnea had significantly poorer safety performance indicators. STOP-BANG and ESS were significant predictors of safety compliance (β 0.228 and 0.370, respectively), safety participation (β 0.210 and 0.144, respectively), and overall safety behavior (β 0.332 and 0.213, respectively). Further, occupational incidents were 2.5 times higher in workers with indicators of excessive daytime sleepiness and 2 times higher in those with obstructive sleep apnea compared with those without.

Conclusion: These findings confirmed that excessive daytime sleepiness is a serious safety hazard, and that both reactive and proactive measures are important to understand the relative contribution of predictor variables.

Keywords: Sleepiness; Sleep apnea, obstructive; Accidents, occupational; Occupational health

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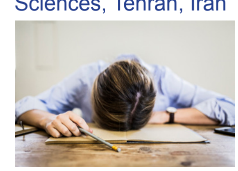

Introduction

Work-related accidents have long been considered one of the most important health, social, and economic risk factors in industrialized and developing societies. Recently, the International Labor Organization has asserted that "globally 1000 people are estimated to die every day from occupational acci-

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Received: Nov 29, 2019
Accepted: Mar 14, 2020

Cite this article as: Gharibi V, Mokarami H, Cousins R , *et al* . Excessive daytime sleepiness and safety performance: comparing proactive and reactive approaches. *Int J Occup Environ Med* 2020;**11**:95-107. doi: 10.34172/ijoem.2020.1872

dents."[1] This figure was extracted from the latest global estimates of fatal workplace accidents, which confirmed that there were approximately 380 000 workplace deaths in the world in the reporting year.[2] Non-fatal accidents resulting in at least four working days lost are not reported in many countries; nevertheless, conservative estimates by Hämäläinen, *et al*, drawing upon available indicators, point to almost 374 million occupational accidents that year (2014). Whilst numbers and rates differed across regions, these were clearly higher in Asia and Africa than in Europe and America. Furthermore, rates of accidents have increased since 2008.[1,2] Hämäläinen suggests that the observed increase in occupational accidents in developing countries would be a consequence of globalization.[3] This increase could be due to the structural changes and the mistaken view of employers in these countries. Structural changes in developing countries and the need for a large workforce in totally new tasks have led to an increase in the employment of untrained workers.[4] On the other hand, the pressures of global competition in these countries may have led employers to view health and safety programs as an additional barrier and cost to their businesses and trade.[5]

The rate of occupational accidents is particularly high in Iran,[6] where work-related accidents have been reported to be more than eight times higher than the world average,[7] with 60% of them in the construction industry.[8] Occupational accidents cause various human and social consequences with irremediable effects on individuals, families, colleagues, and communities, as well as direct and indirect economic losses.[9] Therefore, implementing intervention programs to avoid accidents in the workplace makes good business sense, as well as appealing for corporate social responsibility in all employers. In this regard, assessing the safety of the workplace by measuring the safety performance of employees is considered an important proactive measure.[10]

"Occupational incidents" refers to unintended events that interrupt normal operations, and adversely affect completion of a task; occupational incidents range in severity from "fatal accidents" to "near-misses" in terms of injury.[11,12] Occupational incidents commonly reflect shortcomings in safety programs, and indicate a need for intervention.

Employees' safety performance can be measured using reactive and proactive methods.[11] Reactive or lagging methods evaluate occupational incidents using data collected from the past. Proactive or leading methods measure employees' behavior in the workplace. This would include uptake of safety initiatives, and other training activities that have a goal of preventing accidents.[13,14]

Measuring outcomes using documented objective data has many merits in most fields, however, with respect to safety performance, a focus on safety outcomes raises several problems. First, many occupational incidents are not recorded because of fear of punishment or the attitude that management will not alter work practices if there is a workplace injury.[15] Second, many organizations that do have a reporting system for occupational incidents do not consider how it can effectively contribute to improving safety;[16] and third, the objective criteria of safety performance measurement is only a small contribution to an employee's safety performance. For example, accident rates, and occupational injuries do not give useful information about working conditions or individual behavior that underpins those figures.[17] Thus, using a subjective tool that focuses on employees' safety behavior, as a proactive safety performance index, provides additional information to ensure the safety of workplace. In this regard, identifying and evaluating the factors affecting safety performance of employees is critical for implementing effective interventions.[18]

Sleep disorders and excessive daytime sleepiness (EDS) are regarded as common factors affecting employee's safety performance.[19,20] By nature, humans are active and perform best during the day, and a typical person allocates about 30% of time to sleep at night.[21] Alteration of this natural inclination by a sleep disorder would have adverse and irreparable effects on health.[22] Sleep deprivation is rife,[23] despite being essential for survival, and being associated with impaired cognitive and motor functions.[24] The results of a survey conducted by National Sleep Foundation (NSF) in America show that 26% of workers experience EDS, to the extent of disrupting daily tasks.[25] Sleep deprivation is a serious and growing problem in today's societies, and the number of people with sleep deprivation is rising.[26] A systematic review and meta-analysis of studies that examined the association between obstructive sleep apnea (OSA) and occupational accidents indicate that OSA is one of the most important causes of EDS and increases the odds of occupational accidents by almost two-fold.[27] Various studies have so far investigated the effects of sleep disorders on occupational and traffic accidents,[28-30] however, there is a dearth of research in the safety-critical construction sector.

Although there is some evidence of a relationship between sleep disorders and occupational incidents, there are very limited studies on the effect of OSA and EDS on employee safety performance with regard to leading indicators. In addition, to the best of our knowledge, no study has examined the simultaneous effect of sleep disorders on both reactive and proactive safety measures. We therefore conducted the present study to investigate the relationship between sleep disorders and proactive and reactive indices of safety performance.

Materials and Methods

Study Design and Participants

All employees (n=812) working in the operational and executive sections of an oil construction company in Iran were invited to participate in this cross-sectional study conducted in 2018. The inclusion criteria included absence of any disease in participants affecting their sleep, such as thyroid disorders, diabetes, cardiovascular problems, and renal failure, which could confound the independent variables; and having at least one-year job tenure. The latter criterion was considered for two important reasons: (1) new workers are known to have increased risks until they are fully acquainted with their role, and (2) safety performance evaluation required that employees have a minimum of job tenure to experience safety incidents or safety behavior. Six-hundred and ninty-seven employees were found eligible for inclusion; 661 gave informed written consent and participated in the study.

Measures

Socio-demographic and Work-related Variables

To evaluate and control the effect of socio-demographic confounding variables, a simple survey instrument was developed to collect information regarding age (the total years of life from birth in year), sex, marital status (a worker's relationship with a significant other), body mass index (BMI), educational level (the last educational degree), smoking habit, exercise habit, and job tenure (the total years of work). Exercise habit was a dichotomous response according to doing sufficient exercise to sweat lightly for over 30 min, twice weekly, and for over a year. Smoking habit included two categories:—current smoker and non-smoker.[31,32] To calculate BMI, the weight of workers was measured with minimum clothing and no shoes using a digital scale; their height was measured using a measuring tape in a standing position without shoes.[33]

Excessive Daytime Sleepiness (EDS)

The following two screening scales with good psychometric properties were used to assess EDS:

Epworth Sleepiness Scale (ESS) questionnaire:[34,35] This scale was designed to provide a criterion of participants' propensities to fall asleep in various circumstances. Respondents were asked to rate each of eight items on a 4-point scale (0–3). The total ESS score is the sum of the eight ratings (range 0–24) with higher scores representing greater sleepiness. The ESS has a high sensitivity and specificity with a cut-off value of >10 (abnormal status) for daytime sleepiness. The Persian version of ESS (ESS-IR) also has good psychometric properties.[36] The ESS-IR similarly had acceptable internal consistency and test-retest reliability in this study—Cronbach's α values were 0.77 for men and 0.76 for women.

STOP-BANG questionnaire:[37,38] This tool comprises eight "yes/no" items that identify symptoms associated with OSA: (1) Snoring, (2) Tiredness, (3) Observed apnea during sleep, (4) high blood Pressure, (5) high Body mass index (BMI), (6) Age, (7) large Neck circumference, and (8) Gender. Three or more positive answers from eight items is considered a sign of high risk OSA during sleep (abnormal status). The psychometric properties of the Persian version of STOP-BANG was verified by Sadeghniat, *et al.*[39]

TAKE-HOME MESSAGE

- Sleep disorders and excessive daytime sleepiness negatively affect employees' safety performance.
- There is a negative correlation between safety behavior and its dimensions, safety participation and safety compliance, and OSA (STOP-BANG) and excessive daytime sleepiness (ESS) status.
- Employees with sleep disorders have a poorer safety performance.

Safety Performance

Both reactive and proactive measures of safety performance were collected. Occupational incidents were measured by asking participants to report any occupational accidents or near-misses they had experienced in the past month—lagging indicator, and reactive measure of safety performance.[40] Safety Behavior Assessment[41] was used as a leading indicator to proactively measure the safety performance. This questionnaire consists of 23 questions and two dimensions—safety compliance (12 items) and safety participation (11 items). This instrument was chosen as it was developed in the native language of participants. It has good reliability (Cronbach's α 0.902). Each item was measured using a 5-point response format. Higher scores represented good safety behavior.

Ethics

The research project was approved by the Scientific Committee and Medical Ethics of Shahroud University of Medical Sciences, Shahroud, Iran.

Statistical Analysis

SPSS® for Windows® ver 23 (SPSS Inc, IL, USA) was used for all statistical analyses. Descriptive analyses including mean (SD) and frequency (percent) were used to present socio-demographic characteristics, levels of safety performance, OSA, and EDS in participants. Assumptions of normality were met, and *Student's t* test for independent samples, one-way ANOVA, Pearson's product moment correlation, and χ^2 tests were used to examine the relationship between safety performance scores and independent variables. A p value <0.05 was considered statistically significant.

Hierarchical multiple linear regression analysis was used to examine the effect of sleep disorders on employees' safety performance indicators. Before modelling, variance inflation factor (VIF) was used to check the multicollinearity between independent variables studied. Then, socio-demographic variables (control variables) and the mean of scores of STOP-BANG and ESS questionnaires were entered in the model in the first and second stages, respectively. Variables with p<0.05 were maintained in the final model.

Results

The mean age of participants was 34.7 (SD 8.4, range 23 to 57) years; 95% were male. Almost two-thirds of the participants had higher education and about one-third had personally experienced an occupational accident in their current workplace in the past month (Table 1). According to ESS scores, more than 27% of workers had abnormal drowsiness; based on the STOP-BANG screen, 37.2% of participants had symptoms associated with obstructive sleep apnea (Table 1).

All the studied predictor variables had a significant relationship with safety behavior; only marital status had no relationship with occupational incidents. In general, workers with an abnormal status for ESS (score>10) and STOP-BANG (≥3) had a significantly worse condition in terms of safety performance. In the other words, those with EDS had a lower safety behavior score and more commonly experienced occupational accidents/near-misses (Table 1). In addition, a significant negative correlation was found between safety behavior and its two dimensions, and both the EDS indicators (Table 2).

The VIF rate of all independent variables was <2, indicating lack of multicollinearity between variables. The results from the analysis of multivariate linear regression modeling showed that STOP-BANG and ESS could be used as predictors of safety compliance, safety participation, and total safety performance.

The STOP-BANG and ESS scores had significant negative correlations with safety compliance domain, safety participation domain, and total score of safety behavior. The model could explain 25%, 30%, and 10% of the observed variances in the safety participation, safety compliance, and total safety behavior, respectively (Table 3).The results from the analysis of multivariate logistic regression modeling indicated that both variables of sleep disorder were significant predictors of occupational incidents. Reports of occupational incidents from workers with abnormal ESS and STOP-BANG were about 2.5 and 2 times more than those of workers who were normal, respectively (Table 4).

Discussion

We found a significant negative correlation between EDS and both proactive and reactive safety performance indices; that is, employees with a sleep disorder had a poorer safety performance. The results of regression modeling illustrated a negative correlation between safety behavior and its dimensions, safety participation and safety compliance, and OSA (STOP-BANG) and EDS (ESS) status. Crucially, those employees with abnormal OSA and those with abnormal EDS had lower mean scores for the proactive measures—safety behavior, safety participation, and safety compliance. This result was consistent with outcomes of other studies, which report that employees with sleep disorders

Table 1: Participants' socio-demographic status and their associations with the safety performance indicators (n=661)

		Proactive Index Mean (SD)			Reactive Index Occupational Incidents n (%)	
Characteristics	**n (%)**	**Safety Compliance**	**Safety Participation**	**Total Safety Performance**	**Yes**	**No**
Age (yrs)						
<30	264 (39.9)	3.92 (0.62)	3.40 (0.74)	3.66 (0.58)	87 (33.0)	177 (67.0)
30–40	257 (38.9)	3.85 (0.63)	3.40 (0.66)	3.63 (0.56)	91 (35.4)	166 (64.6)
>40	140 (21.2)	3.61 (0.63)	3.21 (0.62)	3.41 (0.54)	77 (55.0)	63 (4.0)
p value		<0.001†	0.019†	<0.001†	<0.001*	
Sex						
Male	628 (95.0)	3.80 (0.63)	3.34 (0.68)	3.57 (0.56)	254 (40.4)	374 (59.6)
Female	33 (5.0)	4.32 (0.51)	3.70 (0.73)	4.01 (0.56)	1 (3)	32 (97)
p value		<0.001‡	0.003‡	<0.001‡	0.001*	
Marital status						
Single	213 (32.2)	3.92 (0.67)	3.35 (0.77)	3.64 (0.63)	73 (34.3)	140 (65.7)
Married	448 (67.8)	3.79 (0.62)	3.36 (0.65)	3.57 (0.54)	182 (40.6)	266 (59.4)
p-value		0.013‡	0.87‡	0.22‡	0.069*	
Educational level						
Elementary	96 (14.5)	3.64 (0.65)	3.34 (0.61)	3.49 (0.53)	55 (57.3)	41 (42.7)
Diploma	171 (25.9)	3.76 (0.66)	3.34 (0.63)	3.55 (0.54)	83 (48.5)	88 (51.5)
Academic	394 (59.6)	3.91 (0.61)	3.37 (0.73)	3.64 (0.59)	117 (29.7)	277 (70.3)
p value		<0.001†	0.851†	0.035†	<0.001*	
BMI (kg/m^2)						
<25 (normal)	259 (44.6)	3.91 (0.63)	3.39 (0.74)	3.65 (0.59)	91 (30.8)	204 (69.2)
25–30 (Pre-obesity)	325 (49.2)	3.76 (0.63)	3.32 (0.64)	3.54 (0.55)	142 (43.7)	183 (56.3)
>30 (obesity)	41 (6.2)	3.82 (0.64)	3.42 (0.66)	3.62 (0.57)	22 (53.7)	19 (46.3)
p value		0.018†	0.395†	0.063†	0.001*	
Smoking habit						
Yes	244 (36.9)	3.74 (0.65)	3.29 (0.64)	3.52 (0.56)	119 (48.8)	125 (51.2)
No	417 (63.1)	3.88 (0.62)	3.40 (0.71)	3.64 (0.57)	136 (32.6)	281 (67.4)
p value		0.007‡	0.060‡	0.008‡	<0.001*	

Continued

Table 1: Participants' socio-demographic status and their associations with the safety performance indicators (n=661)

Characteristics	n (%)	Proactive Index Mean (SD) Safety Compliance	Safety Participation	Total Safety Performance	Reactive Index Occupational Incidents n (%) Yes	No
Job tenure (yrs)						
<5	226 (34.2)	3.94 (0.60)	3.37 (0.74)	3.66 (0.57)	69 (30.5)	157 (69.5)
5–15	284 (43.0)	3.83 (0.66)	3.41 (0.67)	3.62 (0.58)	106 (37.3)	178 (62.7)
>15	151 (22.8)	3.66 (0.62)	3.25 (0.62)	3.45 (0.55)	255 (38.6)	71 (61.4)
p value		0.001†	0.059†	0.002†	<0.001*	
ESS						
Normal	435 (65.8)	4.00 (0.59)	3.47 (0.73)	3.73 (0.56)	141 (32.4)	294 (67.6)
Abnormal (>10)	183 (27.7)	3.41 (0.58)	3.10 (0.51)	3.25 (0.49)	107 (58.5)	76 (41.5)
p value		<0.001‡	<0.001‡	<0.001‡	0.001*	
STOP-BANG						
Normal	451 (68.2)	4.05 (.55)	3.49 (.71)	3.77 (.54)	124 (29.9)	291(70.1)
Abnormal (≥3)	207 (31.3)	3.36 (.55)	3.10 (.54)	3.21 (.45)	131 (53.3)	115 (46.7)
p value		<0.001‡	<0.001‡	0.001‡	<0.001*	

†One-way ANOVA, ‡*Student's t* test for independent samples; *Pearson χ^2

and EDS have poorer safety behaviors, less safety participation, and pose higher risks to safety compliance.[19,42,43]

The relationship between sleep and safety-related behavior is complex and its mechanism is unknown.[42] It has been suggested that sleep disorders can increase unethical behavior in employees through diminishing self-control resources;[44] there is some evidence that EDS can reduce safety behavior through tiredness and losing focus.[45] In addition, insomnia and other sleep disorders are known to reduce participation in social activities.[19,46] Following from these interpretations, it is likely that sleep disorders reduce safety compliance and safety participation through increased fatigue, reduced concentration, and diminished self-control resources, that are a part of EDS. Further support for this explanation is seen from observing that the safety

Table 2: Mean (SD) of the safety behavior assessment variables and ESS and STOP-BANG scores (n=661) along with the correlation coefficients (*r*) matrix

Variable	Mean (SD)	Variable 1	2	3	4
1) Safety compliance	3.83 (0.64)	1			
2) Safety participation	3.36 (0.69)	0.49	1		
3) Safety performance	3.60 (0.58)	0.85	0.88	1	
4) STOP-BANG	2.89 (0.66)	-0.50	-0.26	-0.43	1
5) ESS	7.41 (4.63)	-0.41	-0.24	-0.37	0.41

All correlation coefficients are significantly (p<0.01) different from zero.

Table 3: Significant variables affecting safety compliance, safety participation, and total safety behavior based on hierarchical multiple regression analysis (n=661)

Characteristics	**Step 1†**			**Step 2††**		
Safety Compliance	**B**	**SE**	**β**	**B**	**SE**	**β**
Age (yrs)						
<30 *vs* >40	0.24*	0.11	0.19*	0.08	0.10	0.06
30–40 *vs* >40	0.20*	0.10	0.15*	0.10	0.08	0.07
Sex (male *vs* female)	-0.45**	0.17	-0.15**	-0.28	0.10	-0.10
Smoking (yes *vs* no)	-0.03	0.06	-0.02	-0.04	0.05	-0.03
Educational level						
Elementary *vs* University	-0.14	0.08	-0.08	-0.08	0.07	0-.04
Diploma *vs* University	-0.07	0.06	-0.05	-0.02	0.05	-0.01
Job tenure (yrs)						
5–15 *vs* <5	-0.06	0.08	-0.05	0.003	0.07	0.02
>15 *vs* <5	-0.01	0.11	-0.01	0.04	0.10	0.02
Marital status (married *vs* single)	0.02	0.06	0.02	0.01	0.06	0.01
BMI (kg/m^2)						
25–30 *vs* <25	-0.10	0.05	-0.07	-0.06	0.05	-0.05
>30 *vs* <25	-0.01	0.11	-0.01	0.09	0.09	0.04
ESS (abnormal *vs* normal)				-0.33**	0.05	-0.37**
STOP-BANG (abnormal *vs* normal)				-0.51**	0.05	-0.23**
Adjusted R^2	0.06**			0.30**		
Safety Participation						
Age (yrs)						
<30 *vs* >40	0.27*	0.12	0.19*	0.17	0.12	0.11
30–40 *vs* >40	0.16	0.11	0.11	0.09	0.10	0.06
Sex (male *vs* female)	-0.32*	0.13	-0.10*	-0.22	0.13	-0.06
Smoking (yes *vs* no)	-0.09	0.06	-0.06	-0.10	0.06	-0.07
Educational level						
Elementary *vs* University	0.05	0.09	0.03	0.09	0.08	0.04
Diploma *vs* University	0.02	0.07	0.01	0.05	0.06	0.03

Continued

Table 3: Significant variables affecting safety compliance, safety participation, and total safety behavior based on hierarchical multiple regression analysis (n=661)

Characteristics	Step 1†			Step 2††		
Safety Participation	**B**	**SE**	**β**	**B**	**SE**	**β**
Job tenure (yrs)						
5–15 *vs* <5	0.09	0.08	0.07	0.11	0.08	0.10
>15 *vs* <5	0.08	0.12	0.05	0.11	0.12	0.07
Marital status (married *vs* single)	0.09	0.07	0.06	0.08	0.07	0.06
BMI (kg/m^2)						
25–30 *vs* <25	-0.05	0.06	-0.03	-0.03	0.06	-0.02
>30 *vs* <25	0.05	0.12	0.02	0.11	0.11	0.04
ESS (abnormal *vs* normal)				-0.22**	0.07	-0.14**
STOP-BANG (abnormal *vs* normal)				-0.31**	0.07	-0.21**
Adjusted R^2	0.02*			0.01**		
Safety Behavior total						
Age (yrs)						
<30 *vs* >40	0.26*	0.10	0.22*	0.11	0.09	0.09
30–40 *vs* >40	0.18*	0.09	0.15*	0.08	0.08	0.07
Sex (male *vs* female)	-0.38**	0.11	-0.14**	-0.25	0.09	-0.10
Smoking (yes *vs* no)	-0.06	0.05	-0.05	-0.07	0.05	-0.06
Educational level						
Elementary *vs* University	-0.05	0.07	-0.03	0.01	0.05	0.01
Diploma *vs* University	-0.03	0.05	-0.02	-0.07	0.05	-0.06
Job tenure (yrs)						
5–15 *vs* <5	0.02	0.07	0.01	0.08	0.06	0.07
>15 *vs* <5	0.03	0.10	0.02	0.07	0.09	0.05
Marital status (married *vs* single)	0.06	0.06	0.04	0.05	0.05	0.04
BMI (kg/m^2)						
25–30 *vs* <25	-0.07	0.05	-0.06	-0.05	0.04	-0.04
>30 *vs* <25	0.02	0.10	0.01	0.10	0.09	0.04

Continued

Table 3: Significant variables affecting safety compliance, safety participation, and total safety behavior based on hierarchical multiple regression analysis (n=661)

Characteristics	Step 1†			Step 2††		
Safety Behavior total	**B**	**SE**	**β**	**B**	**SE**	**β**
ESS (abnormal *vs* normal)				-0.27**	0.05	-0.21**
STOP-BANG (abnormal *vs* normal)				-0.41**	0.05	-0.33**
Adjusted R^2	0.04**			0.25**		

SE: Standard error: B, Unstandardized regression coefficient, β: Standardized regression coefficient
*p<0.05, **p<0.01
†Corrected for age, sex, education level, smoking, and job tenure
‡Corrected for ESS and STOP-BANG level

compliance scale included items concerning obeying safety rules, procedures, and safety instructions and using appropriate equipment. Similarly, the safety participation scale included items examining activities such as helping colleagues, promoting workplace safety plans, and voluntary participation in the workplace health and safety committee.

Our results also showed that sleep disorders have direct effect on occupational incidents in the construction workers who participated in this investigation. This was in line with findings in other sectors.[19,28,30,40,43] Moreover, the results of a meta-analysis conclude that workers with OSA are nearly twice as likely to be at risk of having an occupational incident.[27] In addition, OSA, sleep debt, and EDS, which can be prevented by naps or rest breaks, have been found to significantly predict road traffic accidents.[28] It seems that the reported increase in rates of occupational incidents resulting from EDS was due to fatigue, errors, slips, and cognitive performance impairment.[47-49] Everyone needs sufficient sleep—around 7–8 hours/day—as a homeostatic process to restore cognitive capacities (*eg*, attention processes) and strength and energy levels.[47,50,51] For the same reasons, various studies defined sleep disorders (EDS, OSA, and insomnia) as disrupting factors for self-control and effort in the organization.[52] All of these factors, which are amenable to proactive intervention, such as permitting suitable and sufficient work breaks, and the environment for taking between shift naps, can affect an individual's self-regulatory resources and execution in a safety critical situation.[47,53]

The strengths of the present study are that recruitment was drawn from a large community sample, and the response rate was very good. Also, for the first time, the analysis used a simultaneous evaluation of proactive and reactive approaches; both approaches are known to be important for evaluating the contribution of EDS to occupational incidents. Limitations relate to the use of a cross-sectional design and self-report scales rather than objective evaluations for assessing sleep disorders and safety performance, because of the cost of collecting such data. Nevertheless, the questionnaires have been validated and are widely used in research and in practice, even though they do not represent the gold standard for gathering such data on sleep. Thus, it is recommended that resources to afford polysomnography are considered in future studies.

In conclusion, EDS is a serious hazard in workplaces. It can have a negative effect

Table 4: Significant variables affecting occupational incidents based on logistic regression analysis (n=661). Values are OR (95% CI).

Occupational Incidents	Step 1*	Step 2†
Age (yrs)		
<30 *vs* >40	0.64 (0.31 to 1.34)	0.85 (0.39 to 1.85)
30–40 *vs* >40	0.64 (0.34 to 1.19)	0.75 (0.39 to 1.46)
Sex (male *vs* female)	13.09 (1.74 to 98.38)	10.09 (1.32 to 77.18)
Smoking (yes *vs* no)	1.30 (0.91 to 1.88)	1.36 (0.93 to 1.99)
Educational level		
Elementary *vs* University	2.35 (1.40 to 3.94)	2.26 (1.32 to 3.88)
Diploma *vs* University	1.91 (1.29 to 2.82)	1.85 (1.23 to 2.79)
Job tenure (yrs)		
5–15 *vs* <5	1.17 (0.69 to 1.99)	1.05 (0.61 to 1.82)
>15 *vs* <5	1.39 (0.65 to 2.95)	1.30 (0.59 to 2.87)
Marital status (married *vs* single)	0.70 (0.45 to 1.09)	0.69 (0.43 to 1.09)
BMI (kg/m^2)		
25–30 *vs* <25	1.54 (1.08 to 2.20)	1.50 (1.04 to 2.16)
>30 *vs* <25	2.29 (1.14 to 4.60)	1.95 (0.93 to 4.06)
ESS (abnormal *vs* normal)		2.44 (1.62 to 3.68)
STOP-BANG (abnormal *vs* normal)		2.00 (1.30 to 3.03)

*Corrected for age, sex, education level, smoking, and job tenure
†Corrected for ESS and STOP-BANG level

on employees' safety performance. Therefore, it is essential to improve workers' sleep hygiene through education in all sectors that have high rates of workplace accidents, injuries and near-misses. In addition, better monitoring of sleep hygiene in periodical medical examination of workers, and reviewing systems of allocating breaks, and opportunities for restorative rest during such breaks, are management procedures that will contribute to improving the safety performance in all safety-critical work.

Acknowledgments

This study was supported by Grant No 9594 from Shahroud University of Medical Sciences. The authors appreciate Shahroud University of Medical Sciences for funding and supporting this project.

Conflicts of Interest: None declared.

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