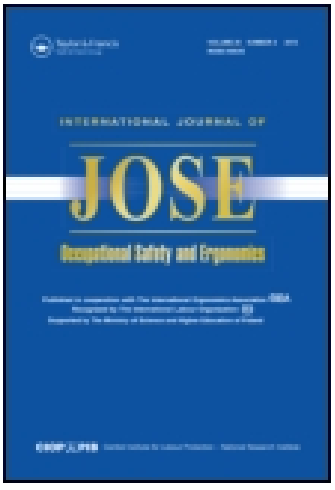

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Occupational Cognitive Failures and Safety Performance in the Workplace

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Introduction. *The majority of industrial accidents occur because of human errors. Human error has different causes, however, in all cases cognitive abilities and limitations of human play an important role. Occupational cognitive failures are cognitively-based human errors that occur at work. The aim of this study was to examine the relationship between occupational cognitive failures and safety consequences.* ***Method.*** *Personnel of a large industrial company in Iran filled out an occupational cognitive failure questionnaire (OCFQ) and answered questions on accidents. Univariate and multiple logistic regression analysis were used to determine the relationship between cognitive failures and safety consequences.* ***Results.*** *According to developed regression models, personnel with a high rate of cognitive failure, in comparison to low rate, have a high risk of minor injury involvement (*OR *5.1, 95% CI [2.62, 10.3]); similar results were for major injury and near miss.* ***Discussion.*** *The results of this study revealed usefulness of the OCFQ as a tool of predicting safety-related consequences and planning preventive actions.*

occupational cognitive failure safety consequences accident involvement
industrial workplace

1. INTRODUCTION

New organizations search for useful tools of predicting safe behaviors in the workplace based on psychological variables [1]. Between different psychological domains, studies focusing on effective individual characteristics on safety and accident involvement tend to cognitive process [2, 3]. Researchers, however, accept that results of cognitive ability and safety studies are very sporadic and require more studies to explore the relationship between these variables [4]. Besides of adoption on predictability of cognitive ability for job performance, still more studies are needed to explore the effect of these abilities in safety behaviors occurrence [5].

Cognitive failure is defined as cognitively based error occurring in a simple task that people can do without any error. These events differ in nature and rate between people. Cognitive failure occurs in occupational and nonoccupational activities. Occupational cognitive failures (OCF) are clusters of failures that occur at working environment [6].

The relationship between general cognitive failures and workplace accidents was examined. Arthur, Barrett and Alexander showed a positive correlation between them and they concluded that accidents occur because of inattention, distraction and mental errors [7]. The same result were obtained in the traffic domain [8]. Other studies also explored the relationship between minor injuries and cognitive failure [9, 10].

A follow up study conducted in an army industry found a positive correlation between cognitive failure and fall injury and hospitalization [10].

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Wallace and Chen found a positive correlation between cognitive failure and accidents and a negative correlation with safety behaviors [11].

In different study, a significant correlation was found between cognitive failure and minor injuries and accidents, however, the relationship between cognitive failures and minor injuries was power than accidents [12]. Studies on assessing the relationship between cognitive failure and safety consequence and focusing on cognitive failure types found that cognitive failures such as memory failure and inattention could predict performance and behavior of people [13, 14].

High prevalence of cognitive failures than minor injury in the working environment could be serving as a reliable resource for predicting safety performance. This study used OCF as an independent variable not general cognitive failures. Power correlation between OCF and different type of accidents was anticipated. The aim of this study was to answer the question: do OCF could help to predict occupational accidents in organizations?

2. METHODS

2.1. OCFQ

The occupational cognitive failure questionnaire (OCFQ) includes 30 items. The questionnaire assesses dominant cognitive failures occurring in the working environment. Items are scored on a 1–5 Likert scale (1 = *never*, 5 = *ever*) [6]. The questionnaire includes items for memory domain ("After you started working, did you realize that you were not using personal protective equipment?"), attention ("Did you fail to pay attention to alarms, voice messages, displays?"), motor function ("Did you press the wrong button or controls on a computer or piece of equipment?") and perception error ("Did you have difficulty in estimating weight, distance or depth?"). The OCFQ range of score is 30–150. For logistic analysis purpose, calculated scores were classified into three groups: low, medium and high rate of OCF.

2.2. Safety Consequences

Three measures of safety performance assessed in this study include major injury which required medical attention in the last 12 months [15], minor injury which is defined as an injury (e.g., cuts and bruises) at work that did not require medical attention in the last 12 months [15] and near miss which is defined as an undesired event that under slightly different circumstances could have resulted in harm to people [16].

The participants were informed about the measures. A self-report method was used to collect data. Previous studies revealed that self-report accident data suggested a high correlation with safety behavior than formal report (such as organization documents) both in personal and group levels. The use of self-report methods could overcome the problem of underestimating injury in health centers [15].

2.3. Participants

The sample group consisted of 605 randomly selected employees from a large industrial company. The participants were male and aged 20–61 years. Their mean (*SD*) age was 31.7 (7.3). The participants were from multiple departments (e.g., production, maintenance and manufacturing) and held diverse occupations.

2.4. Statistical Analysis

Multiple logistic regression, forward stepwise procedures and χ^2 test were used to investigate the relation between accidents as dependent variables and cognitive failures, and demographic and employment situations as independent variables.

OCF, age, education, marital status and shift work were the first items in each regression. The results were expressed as odds ratio (*OR*) with 95% confidence intervals (95% CI). SPSS version 16 was used for data analysis.

3. RESULTS

During the last year of the study, 337 (44.3%) participants were involved in a minor injury. The result of χ^2 test showed that the association

between minor injury and the OCF rate ($p < .001$), shift work ($p = .006$) and education level ($p = .042$) were statistically significant (Table 1). Multiple logistic regression method with forward procedure revealed that the OCF rate and shift work significantly contributed to minor injury involvement (Table 1). Table 1 shows that the increase in the OCF level caused an increase in *OR* of involvement in a minor injury. *OR* of minor injury occurrence for the participant with medium rate of OCF related to low rate were 2.5 (95% CI [1.82, 3.7]). *OR* for the participants with high level of OCF related to low rate were 5.1 (95% CI [2.62, 10.3]). *OR* of involvement in a minor injury for the participant without night shift work related to reference group (2 weeks on/off) was 1.08 (95% CI [0.71, 1.45]) and for the participant with night shift was 2.32 (95% CI [1.35, 4.15]) (Table 1).

During the last year, 172 (28.4%) participants had major injury. On the basis of χ^2 test, only the OCF variable showed significant association with major injury ($p < .001$). The results showed that the increase in the OCF rate caused an increase in *OR* of involvement in a major injury. *OR* of major injury occurrence for the participant with medium rate of OCF related to low rate was 2.4 (95% CI [1.62, 3.57]) and for the participants with high level of OCF related to low rate was 4.88 (95% CI [2.7, 8.81]). During the last year, 51 (18%) participants with low rate of OCF, 90 (34.5%) participants with medium rate of OCF and 31 (51.7%) participants from high rate group had major injury (Table 2).

During the last year, 421 (69.6%) participants had near miss. Table 3 shows that the increase in the OCF level caused an increase in *OR* of involvement in a near miss. *OR* of near miss occurrence for the participant with medium rate of OCF related to low rate was 2.32 (95% CI [1.59, 3.4]). *OR* for participants with high level of OCF related to low rate was 2.43 (95% CI [1.41, 6.1]) (Table 3). *OR* of near miss for the participant without night shift work related to reference

TABLE 1. Odds Ratio (*OR*) Estimations of Minor Injury Based on Multiple Logistic Regression Model

	Participant[a]						
Variable	**Without Accident**	**With Accident**	***p***	**β**	***SE***	***OR***	**95% CI**
OCF[b]							
low	163 (57.4)	121 (42.6)		reference	reference	1	
medium	93 (35.6)	168 (64.4)	<.001	0.940	0.17	2.58	[1.82, 3.7]
high	12 (20.0)	48 (80.0)		0.650	0.35	5.10	[2.62, 10.3]
Shift work							
2-2[c]	112 (45.5)	134 (54.5)		reference	reference	1	1
without night shift	132 (48.0)	143 (52.0)	.006	0.024	0.18	1.08	[0.71, 1.45]
with night shift	24 (28.6)	60 (71.4)		0.868	0.28	2.32	[1.35, 4.15]
Age							
<29	123 (42.9)	164 (57.1)					
30-39	108 (44.4)	135 (55.6)	.600				
>40	37 (49.3)	38 (50.7)					
Education							
<high school	38 (57.6)	28 (42.4)					
high school	81 (42.6)	109 (57.4)					
technical diploma	34 (35.4)	62 (64.6)	.042				
bachelor degree	101 (44.1)	128 (55.9)					
post graduate	14 (58.3)	10 (41.7)					
Marital status							
married	193 (44.7)	239 (55.3)	.760				
single	75 (43.4)	98 (56.6)					

Notes. a = *N* (%), b = occupational cognitive failure, c = 2 weeks on/off working system.

TABLE 2. Distribution of Major Injury

Variable	Participant[a] Without Accident	With Accident	*p*	β	*SE*	*OR*	95% CI
OCF[b]							
low	51 (18.0)	233 (82.0)		*ns*	*ns*	*ns*	*ns*
medium	90 (34.5)	171 (65.5)	<.001	0.870	0.21	2.40	[1.62, 3.57]
high	31 (51.7)	29 (48.3)		1.580	0.30	4.88	[2.70, 8.81]
Shift work							
2-2[c]	63 (25.6)	183 (74.4)					
without night shift	83 (30.2)	192 (69.8)	.440				
with night shift	26 (31.0)	58 (69.0)					
Age							
<29	89 (31.0)	198 (69.0)					
30-39	62 (25.5)	181 (74.5)	.380				
>40	21 (28.0)	54 (72.0)					
Education							
<high school	26 (39.4)	40 (60.6)					
high school	49 (25.8)	141 (74.2)					
technical diploma	30 (31.2)	66 (68.8)	.250				
bachelor degree	61 (26.6)	168 (73.4)					
post graduate	6 (25.0)	18 (75.0)					
Marital status							
married	124 (28.7)	308 (71.3)	.810				
single	48 (27.7)	125 (72.3)					

Notes. a = *N* (%), b = occupational cognitive failure, c = 2 weeks on/off working system.

TABLE 3. Odds Ratio (*OR*) Estimations of Near Miss Based on Multiple Logistic Regression Model

Variable	Participant[a] Without Accident	With Accident	*p*	β	*SE*	*OR*	95% CI
OCF[b]							
low	113 (39.8)	171 (60.2)		reference	reference	1	
medium	60 (23.1)	200 (76.9)	<.001	0.850	0.19	2.32	[1.59, 3.40]
high	10 (16.7)	50 (83.2)		1.010	0.37	2.43	[1.41, 6.10]
Shift work							
2-2[c]	71 (28.9)	175 (71.1)		reference	reference	1	1
without night shift	100 (36.5)	174 (63.5)	.001	–0.270	0.19	0.76	[0.52, 1.11]
with night shift	12 (14.3)	72 (85.7)		0.992	0.35	2.70	[1.36, 5.40]
Age							
<29	87 (30.3)	200 (69.7)					
30–39	78 (32.1)	165 (67.9)	.440				
>40	18 (24.3)	57 (75.7)					
Education							
<high school	26 (39.4)	40 (60.6)					
high school	71 (37.4)	119 (62.6)					
technical diploma	27 (28.1)	69 (71.9)	.010				
bachelor degree	54 (23.7)	174 (76.3)					
post graduate	5 (20.8)	19 (79.2)					
Marital status							
married	131 (30.4)	300 (69.6)	.930				
single	52 (30.1)	121 (69.9)					

Notes. a = *N* (%), b = occupational cognitive failure, c = 2 weeks on/off working system.

group (2 weeks on/off) was 0.76 (95% CI [0.52, 1.11]) and for the participant who has night shift in working schedule was 2.7 (95% CI [1.36, 5.4]) (Table 3).

4. DISCUSSION

The results of statistical analysis suggest that the OCF rate significantly contributed to any type of safety performance measures described in the present study. The increase of the OCF rate caused an increase in *OR* of accident and near miss occurrence. The findings of the present study are similar to the result of other studies which revealed positive relationship between cognitive failure and accidents [7, 9, 10, 12, 13]. People with high rate of OCF involvement caused by different individual and job characteristics are more prone to accidents.

The relationship between other upstream measures of safety performance such as unsafe behaviors was also studied in other studies. A negative and significant relationship obtained as hypothesized, i.e., with increase of cognitive failure rate *OR* of safe behavior occurrence [13, 14]. These findings and the results of the present study suggest that the OCF rate is useful for predicting safety performance in the workplace.

The comparison of *OR* of involving in different type of accident based on the OCF rate suggests that the highest risk was related to minor accident. This result confirms the findings of the previous study [12]; minor accidents are more than major accidents.

The results of regression analysis assessing predictability of safety performance measure with the OCFQ reveal that for every one unit increase in OCF *OR* of involving in all category of accident increased regardless of interference variables. However, working at night has an incremental effect on relationship between OCF and accidents.

The present and previous studies show a positive relationship between cognitive failures and accidents, and suggest that accidents are caused by lack of attention, distraction and mental errors. The large group of participants from the industrial working environment and the questionnaire designed for occupational settings distinguish this study from others. Further studies in different working environments may be required to confirm the findings of this study and strength of OCF as a new independent variable in predicting safety performance.

Human has a great effect on the safety and the reliability of complex systems. Thus, researchers are trying to identify the individual differences that predict safety behavior in the workplace. This allows organizations to utilize employees with more safe behaviors in the workplace and thus the incidence of occupational accidents decreased.

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