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The Relation between Shift Lengths and Occupational Fatigue Dimensions in Filling Station Operators

MASOUD SHAFIEE MOTLAGH[1]; MAJID MOTAMEDZADE[2]; NEDA MAHDAVI[2]*; ABDOLMAJID GARKAZ[1]; ALI REZA SOLTANIAN[3]

[1]*Department of Occupational Hygiene, School of Public Health and Student Research Center, Hamadan University of Medical Sciences, Hamadan, Iran;*

[2]*Department of Ergonomics, School of Public Health and Research Center for Health Sciences, Hamadan University of Medical Sciences, Hamadan, Iran;*

[3]*Modeling of Non-Communicable Diseases Research Center, Department of Biostatistics and Epidemiology, School of Public Health, Hamadan University of Medical Sciences, Hamadan, Iran.*

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ABSTRACT

Shift work is a common work schedule that has several inappropriate consequences, the most important of which is fatigue. The aim of this study was to investigate the impact of the shift length on the occupational fatigue of operators in filling stations. This cross-sectional study was carried out on operators of the filling station in National Iranian Oil Products Distribution Company, Hamadan region, western Iran. Participants were chosen using the random sampling. In order to assess occupational fatigue, the Persian version of Swedish Occupational Fatigue Inventory (P-SOFI) was used in 8, 12 and 24-hour shift schedules. The total score of fatigue (P=0.05), functional fatigue (P=0.001) and conceptual fatigue (P=0.013) had significant difference in various shifts length, but physical dimension score had not significant differences. Among all aforementioned shift works, the 24-h shift had higher fatigue score in P-SOFI. It seems that shift length has a significant impact on occupational fatigue among filling station workers. The result of the study can help to work scheduling and rest-work regime planning for health promotion of workers and accident risk reduction.

KEYWORDS: *Shift length, Occupational fatigue, Filling station operator, Iran*

INTRODUCTION

Nowadays, shift work is a common work schedule that involves hours outside of 8 h daytime work. Shift work has been implicated as a risk factor for several chronic diseases, such as cancer [1] and cardiovascular disease [2]. Shift work is related to several problems such as decrease in safety [3] and productivity [4], interference in personal and social life [5] and occupational fatigue [6]. Fatigue is a general concept experienced by all people, but did not have a clear and comprehensive definition. Fatigue is a general concept experienced by all people, did not have a clear and comprehensive definition.

Multidimensional concept of fatigue manifests itself in mental, behavioral and physiological signs. This is a warning message that indicates body require to rest and recovery [7]. Remarkably, occupational fatigue can lead to an increase in human errors [8], accidents and injuries and decrease in job performance [9].

Workers complain of fatigue are prevalent in the work environment [10]. Imbalance between activity level and work rest periods is a cause of fatigue in the workplace [11]. Quantitative and qualitative assessment of fatigue is essential for managing it. There are several multidimensional

**** Corresponding Author: Neda Mahdavi***

Email: *nmahdavi1@yahoo.com*

instrument for measuring of fatigue, such as (i) Fatigue-Energy-Consciousness-Energized and sleepiness (FACES), (ii) Occupational Fatigue Exhaustion Recovery (OFER) [12], (iii) Fatigue Assessment Scale (FAS) [13] and (iv) Swedish Occupational Fatigue Inventory (SOFI) [14]. SOFI is a multidimensional instrument for measuring occupational fatigue based on self-report tested on multiple worker populations and was reliable [15-16]. SOFI considers the quality and intensity of occupational fatigue, simultaneously [14]. SOFI classifies fatigue variables in five groups, including: Lack of energy, physical exertion, physical discomfort, lack of motivation and sleepiness [14-15]. SOFI can apply for management of occupational fatigue in workplaces.

A large group of workers was employed in service sectors (e.g. police officers, firefighters, health care personnel, and filling station workers). Shift working is an inherent feature of these jobs. Fatigue level in shift work is higher than normal work, significantly [17-18]. The workers of filling station spend more than half of their entire work time in standing posture. A long timework in the standing posture can lead to occupational fatigue. Fatigue is a contributing factor for accidents, injuries and death in a wide range of jobs, with the implications that fatigued workers are less likely to produce safe behaviors, performance and productivity [19]. Unsafe behavior of filling station operators (due to occupational fatigue) can increase the risk of accidents in this critical workplace. The physical demands associated with filling station operator tasks are substantial. In addition, the mental and physical demands vary across filling station workplace. Thus, mental and physical fatigue is likely present among filling station operators and assessment of occupational fatigue is critical for understanding the consequences of fatigue in this high-risk workplace.

This study probably for the first time has investigated the impact of shift length on occupational fatigue with self-reported P-SOFI among filling station operators. The aim of this study was to investigate shift length and its correlation with occupational fatigue in the filling station operators that working in the critical and high-risk workplace.

MATERIALS AND METHODS

This cross-sectional study was carried out in filling station workers in National Iranian Oil Products Distribution Company, Hamadan region, western Iran in 2013. Two hundred and five man operators worked at filling station in National Iranian Oil Products Distribution Company. Operators were selected by random sampling method. In addition, their number in each shift and type of work was determined by the proportional stratified method. Finally, 100 operators include 36 CNG and 64 gasoline operators were participated in periods of 8-h (6%), 12-h (51%) and 24-h (43%) shifts length.

Data collection: The Persian version of Swedish Occupational Fatigue Inventory (P-SOFI) was used for data collection. P-SOFI has good reliability and content validity for measuring fatigue in filling station operators [20]. This inventory assessed perceived fatigue related to work across three dimensions: functional, conceptual and physical fatigue [20]. Functional fatigue is defined as a reduction in the performance of work and effort. In addition, conceptual or mental fatigue is considered as a decrement in performance of cognitive process and alertness. Somatic exhausted, feeling of weariness or physical weakness are considered as physical fatigue.

This inventory contains 20 verbal expressions, each rated on a seven-point scale (0 = not at all - 6 = to a very high degree). In order to address potential sources of bias, participant filled the P-SOFI inventory at the end of the work. Verbal expression rated based on participant feeling when was fully fatigued.

According to P-SOFI, the “functional”, “physical” and “conceptual” fatigue has eight, seven and five sub-dimensions, respectively. The score each dimension of fatigue was obtained from sum of sub-dimension ratings. Finally, the total score of fatigue was calculated by mean of three dimensions in the different shift length.

Ethical considerations: The National Iranian Oil Products Distribution Company, Hamadan region contributed in this study. In addition, filling station operators were informed about the purpose of this research and secretly procedures in the study.

Data Analysis and statistical procedures: All data given by P-SOFI were analyzed with SPSS 20 (Chicago, IL, USA) and were considered statistically significant as $P < 0.05$. Mean (standard deviation, SD) and figures was used to describe the results. Kormogrov - Smirnov tests showed that normal distribution of data in groups. Data were analyzed using Multivariate ANOVA. The Tukey's Post-Hoc test were used for pairwise multiple comparison between different shifts length. The independent variables were included age, education and marital status, type of filling station (Gasoline or CNG) and shift length (8, 12 and 24-h). Total scores of the three dimensions of fatigue including physical, functional and conceptual considered as dependent variables.

RESULTS

Demographic information of operators is

shown in Table 1.

Table1. Demographic information of operators

Variables (n=100)	min	Max	Mean (SD)
Age (year)	18	56	31.32 (6.65)
Work experience (year)	1	21	4.81 (3.53)

Demographic data were including age, marital status, education (degree), years of experience and years of shift work experience, type of filling station, type of task, shift schedule and shift length.

The demographic data indicated that mean of the studied operators' age and work experience of filling stations were 31.3 and 4.8, respectively. Seventy nine percent of participants were married. Education level of 33% of them was less than diploma. The percent of participants that worked in gasoline and CNG stations was 64% and 36%, respectively.

Six percent of filling stations established in the 8-h work shift, 51% in 12-h and 43% in 24-h work shifts. Results of multivariate ANOVA, between independent variables and dependent variable (occupational fatigue) are summarized in Table 2.

Table2. Multivariate ANOVA, the independent variables (marital status, education level, and shift length), the dependent variables (physical, cognitive and functional scores of fatigue in P-SOFI)

Independent variable		Score of functional fatigue dimension		Score of physical fatigue dimension		Score of conceptual fatigue dimension		Total score of occupational fatigue in P-SOFI	
		Mean (SD)	p-value	Mean (SD)	p-value	Mean (SD)	p-value	Mean (SD)	p-value
Marital status	Married	2.80 (1.22)	0.13	3.28 (1.52)	0.031#	2.60 (1.27)	0.702	8.67 (3.53)	0.19
	Single	2.72 (1.42)		2.56 (1.31)		2.82 (1.44)		8.10 (3.76)	
Educational level	Under dip	2.62 (1.53)	0.70	2.93 (1.26)	0.299	2.63 (1.22)	0.895	8.18 (3.55)	0.599
	Diploma and higher	2.85 (1.21)		3.23 (1.61)		2.65 (1.35)		8.73 (3.6)	
Type of work	Gasoline operator	3.11 (1.14)	0.58	3.29 (1.17)	0.285	2.99 (1.23)	0.523	7.06 (3.77)	0.185
	CNG operator	2.19 (1.14)		2.83 (1.17)		2.04 (1.21)		7.64 (3.77)	
Shift length	8-hours	1.25 (0.47)	0.001#	2.21 (1.03)	0.204	1.53 (021)	0.006#	4.1 (a.48)	0.004#
	12-hours	2.61 (1.22)		3.03 (1.74)		2.47 (1.32)		8.12 (3.65)	
	24-hours	3.18 (1.17)		3.37 (1.26)		3.00 (1.26)		9.56 (3.29)	

Fatigue levels: Shift length is an effective variable on total score of fatigue (P=0.004). The fatigue levels were significantly different between various shifts length (P=0.05). The fatigue levels differed between 8-h and 24-h work shifts (P=0.008). The total score of fatigue in 8-h and 24-h work shifts was 1.6 and 3.2, respectively. Post hoc comparisons showed that fatigue level was not different between 8-h and 12-h work shifts and between 12-h and 24-h work shifts.

The mean of functional, conceptual and physical fatigue scores of P-SOFI inventory in various shifts length is plotted in Fig. 1.

Functional dimensions of fatigue: Univariate ANOVAs indicated that functional fatigue levels from the P-SOFI functional dimension had significant correlation with age (P=0.018) and shift length (P=0.001). The functional fatigue levels were significantly different between various shifts length (P=0.001). In addition, the functional fatigue levels differed between 8-h and 24-h work shifts (P=0.001) and between 8-h and 12-h work shifts (P=0.024) and between 12-h and 24-h work shifts (P=0.051). The mean score of functional fatigue dimension in 8-h, 12-h and 24-h work shifts were 1.25, 2.61 and 3.18, respectively.

Fatigue levels: Shift length is an effective variable on total score of fatigue (P=0.004). The fatigue levels were significantly different between various shifts length (P=0.05). The fatigue levels differed between 8-h and 24-h work shifts (P=0.008). The total score of fatigue in 8-h and 24-h work shifts was 1.6 and 3.2, respectively. Post hoc comparisons showed that fatigue level was not different between 8-h and 12-h work shifts and between 12-h and 24-h work shifts.

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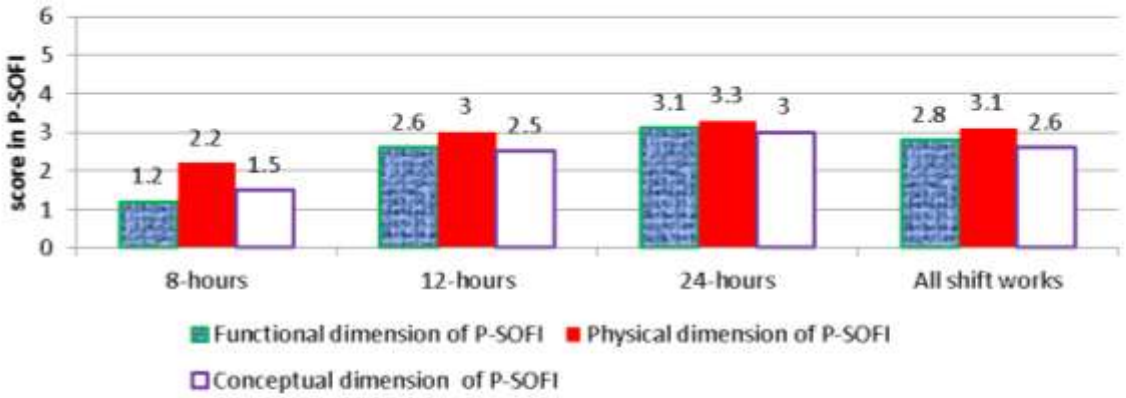

Fig 1. Differences in P-SOFI functional, conceptual and physical fatigue scores (higher = increased fatigue) across 8, 12 and 24 hour work shifts

Functional dimensions of fatigue: Univariate ANOVAs indicated that functional fatigue levels from the P-SOFI functional dimension had significant correlation with age (P=0.018) and shift length (P=0.001). The functional fatigue levels were significantly different between various shifts length (P=0.001). In addition, the functional fatigue levels differed between 8-h and 24-h work shifts (P=0.001) and between 8-h and 12-h work shifts (P=0.024) and between 12-h and 24-h work shifts (P=0.051). The mean score of functional fatigue dimension in 8-h, 12-h and 24-h work shifts were 1.25, 2.61 and 3.18, respectively.

Conceptual dimensions of fatigue: Shift length was effective variable on the conceptual fatigue dimension (P=0.006). The conceptual fatigue levels were significantly different between various shifts length (P=0.013). The conceptual fatigue levels differed between 8-h and 24-h work shifts (P=0.023). The mean score of conceptual fatigue dimension in 8-h and 24-h was 1.53 and 3, respectively. Post hoc comparisons showed that conceptual fatigue level was not different between 8-h and 12-h work shifts and between 12-h and 24-h work shifts.

Physical dimensions of fatigue: Physical fatigue levels were not significantly different between various shifts length (P=0.502). Univariate ANOVAs indicated that the physical fatigue dimension had significant correlation with marital status (P=0.031). The mean score of physical fatigue dimension in married and single operators was 3.28 and 2.56, respectively.

Generally, the mean score of functional, physical, conceptual dimensions and total fatigue was 2.8, 3.1, 2.6 and 8.55, respectively. Besides, the mean scores of functional, conceptual, physical, and total fatigue of P-SOFI inventory among gasoline and CNG filling station operators has been shown in Fig. 2.

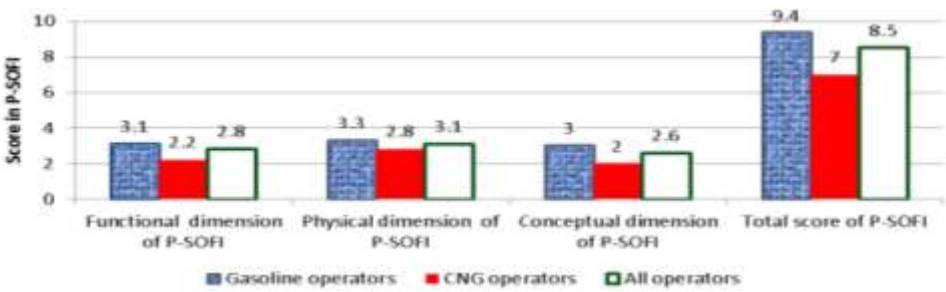

Fig 2. Differences in gasoline and CNG filling station operators in dimension of fatigue scores (higher = increased fatigue)

DISCUSSION

Based on the P-SOFI classifications, occupational fatigue has three dimensions: physical, conceptual and functional [21], but SOFI has five dimensions [14]. In the SOFI, physical exertion and physical discomfort can be categorized in to physical dimension and lack of motivation and sleepiness can be categorized in to mental dimension [15].

The findings of current study of assessing functional, conceptual, physical and total fatigue in filling station operators in the various shifts length (8, 12 and 24-h work shifts) revealed that fatigue was quite high (Figs 1 and 2).

In addition, physical fatigue of filling station operators was higher than functional and conceptual fatigue in all work shifts. Physical dimension of fatigue was high in firefighters, physiotherapists and goods traffic drivers in city areas; while operators in a nuclear power plant and cloakroom attendants experienced highest fatigue in the mental dimension [14].

The high scores of physical fatigue compared with functional and conceptual fatigue in operators may be attributable to prolonged standing and repetitive task in filling station workplaces. The operators of filling station were working on standing posture in entire period of their shift. In addition, there were not convenient facilities and regular schedule for short breaks for operators. Thus, the physical fatigue was highest in operators.

The score of physical and total fatigue in gasoline operators were more than CNG operators were (Fig. 2). This may be attributable to effect of materials that gasoline operators exposed to it. However, occupational chronic exposure to the gasoline compounds can lead to complications such as headache, fatigue [21], insomnia, increase emotional excitability and reduced memory (22). Therefore, in future studies, the effect of occupational exposure of gasoline compounds on the fatigue can be investigated.

Operators perceived higher levels of functional and conceptual fatigue in 12 and 24-h work shifts compared with the 8-h work shift. In addition, 8-h work shift is preferred than the other shifts. The result of our study confirmed ergonomics approach in work scheduling and good agreement with other studied [23-25]. Twelve-h work shift with several short break times is safer than a 8-h shift work with a short break time [4]. The prolonged work hours have been linked with the increase fatigue and unhealthy life behaviors, decrease in performance and reaction time, thereby, increase likelihood of injuries and accident rates [23, 26]. Furthermore, perceived fatigue depend on shift length, period of the workdays, number of work shifts before a rest day, number of rest days before the shift, quality and quantity of rest time between shifts [27]. Notwithstanding risk factors such as long working hours, flexible work time has a positive effect on the mental health of workers (28). In addition, regular medical examinations can reduce shift work-related problems [29].

The perceived levels of physical, functional and total fatigue were significantly different between several of the demographic variables. The functional fatigue levels differed in age ranging. Demographic information such as age, sex and personality are important to assessing fatigue [30]. Age is an important factor that influence operator performance in normal work schedule and shift work schedule [31]. The physical fatigue levels differed in married and single operators. In other words, married operators felt higher physical fatigue level in compared with single operators. This confirms previous findings that marital people experienced greater fatigue [32]. Therefore, special attention should be paid to older married operators in work scheduling of filling stations.

It is important to note that most of filling stations are located in urban residential areas, thereby; accident in critical workplace will be catastrophic consequences. Thus, proper and correct planning of work schedule and shift-scheduling policies can reduce the effect of shift work on perceived fatigue and reduce the risk of accidents and injuries. As well as proper work schedule and work-hour, limitation may promote mental health.

Although this study has reached its goals, there was an unavoidable limitation. It is possible that filling station operators has not reported the actual level of fatigue, because they were concerned about losing their jobs.

CONCLUSION

Working in 8-h shift, leads to occupational fatigue, less than 12 and 24h shifts length. Furthermore, filling station operators reported higher levels of physical fatigue than functional and conceptual fatigue. Managers should consider these results when designing work schedules for filling stations to avoid excessive fatigues and its consequences. It is believed that this work could be useful for planning of an ergonomic work schedule and safety risk management. Future studies are needed to build on the associations between causal implications of shift length on health and safety issues for filling station operators.

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