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Association between Shifting Work and Musculoskeletal Disorders among Workers Working in Steel Industry Application of Multivariate Logistic Regression

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ABSTRACT

Aims: Due to the increasing development of industries and the need for continuous and intensive work, work-related diseases, such as Work- Related Musculoskeletal Disorders (WRMSD), have increased. The present study was carried out to evaluate the association between shifting work and WRMSD.

Instruments &Methods: This cross-sectional study was carried out on 300 male workers recruited from Mobarakeh Steel Company Esfahan, Iran during May 2015 till June 2016. The participants in this study were selected by two-stage random sampling (stratify-cluster sampling) in 3 shift categories (day worker, ordinary and rotation shifting worker) and then responded to the Nordic Musculoskeletal Questionnaire (NMQ). Data were analysed using SPSS software (version 24) and ML-win software (version 2.3).

Findings: The mean age of the participant was 42.4(SD=8.19), 39.82(SD=8.48) and 44.4(SD=3.57) years in day worker, ordinary and rotation shift worker respectively. The results showed that over the past seven days, the risk of shoulder disorders in ordinary shifts was significantly (OR=1.66, P-value=0.04) higher than the rotational shift. The risk of elbow disorders during the seven days or the past 12 months in ordinary shifts was significantly (OR = 0.38, P-value=0.01) lower than the rotational shift worker.

Conclusion: According to the result of this study, considering shifting work greatly is helpful in preventing WRMSD. Therefore, it is necessary to pay more attention to working conditions and risk factors for shoulder, elbow, and legs disorders.

Keywords: Musculoskeletal Disorders, Shifting Work , Steel Industry .

Introduction

Today's industrial world has brought the growing trend of production rate in shorter time. Therefore, it is not possible such as speed and production without shifting work. In general, shifting work is work that takes place on a schedule outside the traditional time means from 9 am – 5 pm daily [1]. In different jobs, depending on the type of work and the need for more workforces, the shifting work has been defined accordingly. The previous study showed that shifting worker tends to health problems like overweight [2-4], high-blood pressure [5, 6], high lipid disorder [7], sleep disorders[8] and WRMSDs [9, 10]. The previous study also showed that working in unusual shifts reduces awareness and attention during the day [11]. On the other hand, reduced attention and vigilance during daily activities could cause a lot of Musculoskeletal Disorders (MSD) and financial and psychological losses [12]. Now day WRMSDs in the industries has been continuously increased [13-16]. WRMSDs are one of the most common causes of occupational injuries in developing countries which refers to any tissue damage to the musculoskeletal and nervous system that affects the individuals' function[17]. Furthermore, they lead to direct and indirect costs and high work-related absenteeism [18-

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20]. WRMSDs, in addition to ergonomic exposures, depends on other factors such as age, sex, body Mass Index (BMI), daytime work, mental stress, and physical fitness [21-25]. In other hands, in different jobs, type of working and the need for more workforce, working in unallowable and unusual hours of the day could be resulted in WRMSDs. Regarding the importance of social and sanitary effects of -shifting work and the occurrence of muscular disorders, especially in night shifts, and the association of some of these disorders with shifting work and its related outcomes, this study aimed to assess the association between shifting work and WRMSDs among steel company workers.

Instruments and Methods

This cross-sectional study conducted in Esfahan Mobarakeh Steel Company (EMSC), Iran from May 2015 to June 2016. The aim of this study was to investigate the effects of shifting work on WRMSDs in all staff and male workers who work in the Company. This study was carried out on a sample of 300 people, using a two-stage (stratified-cluster) sampling method. In this study, we use the formula $(n = \left(Z_{\frac{\alpha}{2}} + Z_{\beta}\right)^2 / d^2 + 1)$ for estimating the sample size by considering $\alpha = 0.05$, $\beta = 0.1$ and $d = 0.2$. The sample size was calculated as 263 workers. Considering 14% of the sample loss, 37 samples were added and finally, 300 workers considered to be studied in this study. In this study, the willingness to participate, formal or contractual employment and having at least two years of work experience at EMSC considered as inclusions criteria Moreover, unwillingness to participate, expulsion, death or retirement during study considered as exclusions criteria. The participants were fully satisfied and confidentially information was considered with researchers in this study. The Medical Ethics Committee of the Tarbiat Modares University (TMU) approved the ethical protocol of this study (IR.TMU.REC.1396.589). In this study, the definition of shifting schedule fully described by Gholami et al paper[18]. In this study, participate fill out demographical questioner in addition Nordic Musculoskeletal Questionnaire (NMQ). The NMQ is yes/no structured interview questionnaire includes the human body image that is divided into nine parts of body including neck, shoulder, elbows, wrists and hands, waist up, lower back, thighs, knees, ankles, and legs. In this questionnaire, participants provided information on their musculoskeletal disorders in the past 12 months (outbreak) and 7 days ago (starting point) [12]. The validity and reliability of this questionnaire reported in previous the studies [18, 26].

Statistical Analysis

In this study, we used multilevel logistic modelling for analysis multivariate logistic regression. In the first multivariate binary, the responses were restructured to one column and each response considered as a repeat of one response. Actually, this approach tends to share parameter in joint modelling [18]. Since multilevel models consider the correlation between observations, they provide more accurate results than compared to simple logistic regression analysis [27, 28]. In multivariate responses, there is the possibility of data loss which can lead to loss of information and missed values. The presence of missed values may decline the accuracy of calculated statistical indicators and subsequently increase the complexity of the model and statistical methods. Since results from incomplete data can be resulted in bias, these data analysis should be done in inappropriate way [11, 29-31]. Multilevel model is a suitable method because it does not require data with balanced structure [27, 29, 32]. Data were analysed by ML-win and SPSS software. Descriptive statistics (mean, standard deviation, frequency, and percentage) were used to describe the demographic characteristics. The adjusted OR and Mann–Whitney index were used for testing the hypotheses. Normality of the data was checked by using the Kolmogorov-Smirnov test. The significance level of less than 5% was used as a meaningful level of acceptable.

Findings

The demographical information of the participants according to the shifting schedule are presented in Table (1) and Table (2). According to the results of these two tables, we can see rotation shifting workers are older, more experienced, more smoker, and lower educated and lower weighted rather than day worker and ordinary shifting workers. Since age, experience, education and smoke status were significantly different, so in final analysis such variable was controlled. The results of the Odds Ratio (OR) are presented in Table (3). As it is shown in this table, the risk of MSD in rotation shifting is greater than day shifting worker. It can also be seen that the risk of shoulder disorders in the ordinary shift was higher (OR=1.66) than day shifting worker significantly over the past seven days (P=0.04). The risk of elbow disorders during the seven days or the past 12 months in ordinary shifting workers was reported 62% (OR=0.38) that was less than day shifting worker (P=0.01). Other disorders were not significant different according to the shifting schedule.

Discussion

Because of the importance of WRMSDs and shifting work, this study was performed to explore the association between shifting work and WRMSDs among steel company workers. The result of this study showed that positive risk of WRMSDs in rotation shift rather than day shifting worker. This finding was in the line with the previous study [33, 34] that can be attributed to shifting work experience. Jeff et al reported that diseases such as high blood pressure, gastrointestinal ulcers, chronic worries, asthma and allergies, WRMSDs, and severe obesity among middle-experience shifting workers have been around 40% more than shifting workers with less experience [35]. Thus, it can attribute to the high work pressure in shifting work. Choobineh et al showed that significant signs of WRMADs are high in nurses with high physical pressures. Back pain is the most prevalent problems among such nurses [36]. The results also showed the decreasing effect of working in shifting work on risk of elbow disorders. Such phenomena can be explaining by a higher risk of knee disorder in day shifting worker because of their job position rather than shifting worker [37]. In contrast with Lipscomb et al study [9] and Adel et al. the present study have not shown any significant relationship between shifting work and neck, wrists/hands, upper and lower back, one/both hips/thighs/buttocks, one/both knees , one/both ankles/feet disorders.

Strength and Limitation

A limitation of this study is sample selection from a single company and job category. In contrast, performing of risk assessment for all staffs without considering their knowledge, selecting large sample and use of reliable statistical analysis methods were considered as the strength points of this study.

Conclusion

According the findings of this study, it could be concluded that early preventions such as the replacement of mechanized methods instead manual methods, ergonomic modification of the work environment, the training of the correct use of work tools and correct posture when using these tools are effective in preventing WRMSDs in shifting worker. It is also necessary to pay more attention to working conditions and risk factors for shoulder, elbow, and legs.

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Table 1 Quantitative demographic variables according to the groups of schedules of work shifting

Variables	Measurements	shift schedule						P-value
		Day shifting		Ordinary shifting		Rotation shifting		
		Mean	SD	Mean	SD	Mean	SD	
Age	year	42.40	8.19	39.82	8.48	44.40	3.57	0.005
Experience	year	16.01	7.99	15.17	7.67	20.48	2.74	0.006
BMI*	Kg/m2	27.08	4.04	26.08	3.13	25.52	3.38	0.057

*BMI: Body Mass Index

Table 2: Qualitative demographic variables according to the groups of schedules of work shifts

Variable	level	shift schedule						P-value
		Day shifting		Ordinary shifting		Rotation shifting		
		N	%	N	%	N	%	
Education	Diploma or Lower	82	59.0	124	91.2	25	100.0	<0.001
	Upper Diploma	57	41.0	12	8.8	0	0.0%	
Marriage	Married	131	94.2	123	90.4	23	92.0	0.494
	Single	8	5.8	13	9.6	2	8.0	
Smoking	No	46	90.2	58	71.6	8	47.1	<0.001
	Yes	5	9.8	23	28.4	9	52.9	

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Ethical permission

Participants in the study, after hearing the explanations of the researchers, read the consent form and signed it. Then they entered into the study. Medical Ethics Committee of faculty of medical sciences of TMU approved the study (**code number: IR.TMU.REC.1395.398**).

Competing interests

There are no conflicts of interest for this study.

Authors' contributions

V.B. Collected the data analysed and prepared the first draft of the article. Gh. F.M supervised all parts of the project.

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Table 3: The odds ratio of musculoskeletal disorders in ordinary and rotation shifting worker compared with day shifting worker.

Disorders		Recent 7 Days	Recent 12 Months	Recent 7 Days or 12 Months
Neck	Day shifting	Considered as reference category		
	Ordinary Shifting	1.16 (0.51,2.64)	1.31 (0.66,2.6)	1.28 (0.65,2.53)
	Rotation shifting	2.29 (0.72,7.33)	2.94 (1.01,8.54)	3.44 (1.17,10.13)
	P-value	0.37	0.14	0.08
Shoulders	Day shifting	Considered as reference category		
	Ordinary shifting	1.66*(0.48,5.76)	1.35 (0.52,3.48)	1.35 (0.52,3.48)
	Rotation shifting	6.06 (1.43,25.67)	2.84 (0.8,10.09)	2.84 (0.8,10.09)
	P-value	0.04	0.27	0.27
Elbows	Day shifting	Considered as reference category		
	Ordinary shifting	0.52 (0.08,3.21)	0.15 (0.02,1.31)	0.38**(0.09,1.57)
	Rotation shifting	4.27 (0.78,23.27)	2.48 (0.53,11.55)	3.91 (1.03,14.77)
	P-value	0.07	0.06	0.01
Wrists/Hands	Day shifting	Considered as reference category		
	Ordinary shifting	1.92 (0.86,4.29)	1.16 (0.54,2.46)	1.55 (0.74,3.25)
	Rotation shifting	2.55 (0.79,8.23)	1.73 (0.56,5.4)	2.21 (0.73,6.68)
	P-value	0.18	0.64	0.3
Upper Back	Day shifting	Considered as reference category		
	Ordinary shifting	1.13 (0.34,3.73)	1.43 (0.53,3.86)	1.71 (0.65,4.52)
	Rotation shifting	1.55 (0.27,8.74)	1.71 (0.4,7.43)	1.71 (0.4,7.43)
	P-value	0.88	0.7	0.53
Lower Back	Day shifting	Considered as reference category		
	Ordinary shifting	0.89 (0.44,1.8)	1.18 (0.62,2.24)	1.23 (0.65,2.35)
	Rotation shifting	1.88 (0.65,5.46)	3.21 (1.03,10.01)	3.21 (1.03,10.01)
	P-value	0.37	0.13	0.13
One/both Hips/ Thighs/Buttocks	Day shifting	Considered as reference category		
	Ordinary shifting	1.35 (0.31,5.87)	1.35 (0.31,5.87)	1.21 (0.33,4.48)
	Rotation shifting	4.27 (0.78,23.27)	6.1 (1.22,30.33)	4.5 (1,20.21)
	P-value	0.21	0.05	0.1
One/both Knees	Day shifting	Considered as reference category		
	Ordinary shifting	1.08 (0.51,2.32)	1.24 (0.62,2.47)	1.12 (0.57,2.19)
	Rotation Shift	2.77 (0.93,8.27)	1.5 (0.51,4.41)	1.91 (0.67,5.48)
	P-value	0.16	0.72	0.48
One/both Ankles/ Feet	Day shifting	Considered as reference category		
	Ordinary shifting	0.92 (0.39,2.14)	0.69 (0.31,1.56)	0.75 (0.34,1.64)
	Rotation shifting	1.76 (0.53,5.89)	1.33 (0.41,4.34)	1.59 (0.52,4.93)
	P-value	0.55	0.48	0.4

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