Investigation of musculoskeletal disorders and its relevant factors using quick exposure check (QEC) method among seymareh hydropower plant workers

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Abstract

Musculoskeletal disorders (MSDs) are one of the most important problems in advanced and industrialized countries particularly in manufacturing companies. Determination of disorders and its relevant factors are one the most leading basis for musculoskeletal disorder prevention programs in the future.The aim of this study was to determine work-related musculoskeletal disorders and its related risk factors among hydropower plant workers. This cross sectional study was done in a hydropower plant located. All 215 workers in hydropower plant were examined. Workers were divided into 11 working groups. To perform the study, ergonomic assessment tools such as QEC (Quick Exposure Check) and validated Nordic Questionnaire were used. The results of Nordic Questionnaire and ergonomic assessment tool showed that low back and wrists symptoms were the most general musculoskeletal signs in workers. Significant differences were found between the prevalence of the MSDs in the upper limbs and the age groups and work experience of workers. Job groups were viewed as a risk factor for musculoskeletal disorders in the upper limbs. Marital status had no important effect on musculoskeletal disorders in the upper limbs such as shoulders, arms, back, neck, wrists and hands. Musculoskeletal disorders had a high prevalence among workers in this hydropower plant and control measures are required to minimize occupational exposure to work-related musculoskeletal disorders risk factors.

Keywords: Occupational Exposure, Power Plant, Risk Factors

Introduction

Musculoskeletal disorders (MSDs) are the damages and injuries of joints, ligaments, nerves, tendons, muscles, spinal discs and cartilage [1]. These disorders started with fatigue and pain, and the disease limits movement of limbs and decreases in strength and power of muscle [2]. Duration of work, repetitive activities and body posture are the main risk factors for MSDs in workplaces [3,4].

Musculoskeletal disorders (MSDs) are one of the most important problems in advanced and industrialized countries particularly in manufacturing companies [1]. MSDs have long term effects on workers daily activities [5]. Musculoskeletal disorders are

the most common work related diseases and are the main reason for loss of working time. Musculoskeletal injuries are the leading cause of work related absenteeism, and according to reports, about 40 percent of compensation cost is paid to workers [2]. According to the data provided by Statistical Centre of Iran (2001) more than 1.13% of the government general budget was spent for MSDs [6].Therefore, work condition modifications are important and will help decrease the incidence of MSDs in manufacturing industries.

Choobineh et al (2012) results showed that the prevalence of musculoskeletal disorders among assembly workers in body area such as neck, lower back, and shoulder/upper arm were more than 70%. Also their findings indicated that ergonomic interventions can reduce musculoskeletal symptoms in neck, shoulder/ upper arm, lower back, elbows and lower arm [2]. Evaluating the risk factors of work-related musculoskeletal disorders in assembly workers of Nishabur showed that musculoskeletal symptoms experienced in wrist (33.0%), neck (21.3%), and waist (21.3%) [7]. Ariens et al [8] findings indicated that the poor working posture has an adverse effect on neck.

The results of Punnett and Wegman study showed that the main reason for MSDs was repetitive work activities and heavy lifting [9]. Other studies have pointed out that female reported a higher rate of musculoskeletal disorders than male due to varying of ergonomic exposures including awkward postures, more repetitive tasks and few job varieties [10,11].

Several studies have produced estimates of musculoskeletal disorders in several workplaces, but there is still insufficient data for an exact determination of musculoskeletal disorders in hydropower plants.

Workers play key roles in hydropower plants. Working in a static position causes MSDs mainly in upper limbs such as back, wrists, neck, shoulders, and arms. Understanding the relationship between occupational exposure parameters and the health consequences of the musculoskeletal disorders is the foundation for MSDs prevention programs [12]. The aim of this paper is to determine musculoskeletal disorders and its relevant risk factors among Seymareh hydropower plant workers. This paper seeks to identify the relationship between workplace factors and work related musculoskeletal disorders.

Method

This cross sectional study was examined the workers at the age range of 20-60 years old. Census method was used to select workers and all of 215 male workers in the hydropower plant participated in the study. The plant has 12 work units and workers involve in 3 shifts. Workers were divided into 11 working groups including stunt box workers, repair workers, cement molding workers, hull cleaners, concrete laboratory workers, metal bar workers, topographers, dig and injection workers, welders, kitchen workers and drivers. Workers with previous musculoskeletal disorders were excluded from this study. To perform the study, QEC (Quick Exposure Check) method for assessing ergonomics condition at the workplaces and demographic questionnaire as to age, weight, gender, work experience, marital status and the type of job were used [13]. Method of QEC (Li and Buckle (1998)) which is viewed as a pen-paper observational method was used to asses the hydropower plant workers ergonomic conditions [14]. It has been designed for use in the occupational safety and health area to asses the risk factors for MSDs and provides a foundation for ergonomics intervention programs at the workplaces [15]. QEC was used because this method considered many risk factors for poor ergonomics conditions at the workplaces. The QEC approach includes a number of attractive features such as the time spent for doing tasks, hand force exertion, maximum applied force by one or two hands, the degree of tasks visual demands, and workers response to the ergonomic conditions. After surveying the tasks using QEC method, the main procedure was followed and each body posture gained its score. QEC method needs more time to follow

each task (approximately 5 minutes) therefore it is acceptable for few number of tasks. To solve the problem, a computer program was used to asses the ergonomic conditions. This program enables users to get the results rapidly and it needs only to enter the QEC parameters. QEC computer software program can actually reduce the assessment time to 20 seconds. The method results were classified in 4 levels. The third and fourth levels need to modification measures. This modification measures in fourth levels should be done immediately [16]. Validated Nordic Questionnaire (Cronbach's alpha test 83.5 %.) was used to examine the symptoms of musculoskeletal disorders among hydropower plant workers within the previous 12 months [17,18].

Data were analyzed using SPSS 16 for windows (version 16, P-Value < 0.05 was defined as statistically significant). An ANOVA test was used to examine the relationship between the upper limb disorders and its relevant risk factors. Two independent samples t-test were used to assess ergonomics condition using QEC method.

Results

The average age of workers was 32±9.81 years old. 72.1% of workers were married. It can be seen from Nordic Questionnaire data in Table 1 that body sites such as lower back (48%), Wrist (41%) and knee (36%) showed the most musculoskeletal disorder symptoms in hydropower plant workers.

Table1 *Musculoskeletal disorder symptoms in different body sites*

Body regions	Incidence (%)
Leg	20.1
Upper back	33.2
Neck	18
Lower back	48
Knee	36
Arm	29
Wrist	41
shoulder	28.3

The result of QEC method showed that a large number of workers have high level of occupational exposure to ergonomic risk factors. As Table 2 shows, there is a significant association between the incidences of MSDs in the upper limbs and age groups parameter (P = 0.007).

Table 2 *The relationship between age groups and the risk of MSDs in the upper limbs*

Age group (year)	Number of worker	Average score of posture	SD	Confidence interval 95%		F Statistic	P-Value
				Upper limit	lower limit		
<20	6	55	12.267	67.85	42015		
21-30	106	58.73	16.162	61.84	55.61		
31-40	58	61.40	10.304	65.42	57.37	3.641	0.007
41-50	28	69.04	11.758	76.10	66.98		
51-60	17	68.06	20.584	78.64	57.48		

From the data in Table 3, the results of ANOVA test revealed that there was a significant difference between job groups and the risk of musculoskeletal disorders in the upper limbs such as shoulders, arms, back, neck, wrists, and hands (P = 0.01).

The ANOVA test showed a significant difference between work experience and the risk of musculoskeletal disorders in the shoulders, arms, back, neck, wrists, and hands.

The Table 5 indicates that the results of two independent samples t-test showed no significant association between marital status and the risk of musculoskeletal disorders in the upper limbs such as shoulders, arms, back, neck, wrists, and hands.

Table3 *The relationship between job groups and the risk of MSDs in the upper limbs*

Job	Number of worker	Average score of posture	SD	Confidence interval 95%		F statistic	P-Value
				Upper limit	Lower limit		
Stunt box workers	42	67.29	13.234	17.41	63.16		
Repair workers	30	63.70	16.002	69.68	57.72		
Hull cleaners	17	60	22.959	71.80	48.20		
Cement workers	31	59.97	22.409	68.19	51.75		
Concrete Laboratory workers	13	54.31	18.531	65.51	43.11		
Metal bar workers	31	60.32	12.262	64.82	55.82	1.218	0.01
Topographer	7	53.14	9.371	61.81	44.48		
Dig and injection workers	12	57.42	9.756	63.62	51.22		
Welders	17	61.24	13.618	68.24	54.23		
Drivers	5	65.60	2.966	69.28	61.92		
Kitchen workers	6	64	11.983	76.58	51.42		

Table4 *The relationship between work experience and the risk of MSDs in the upper limbs*

Work experience (year)	Number of worker	Average score of posture	SD	Confidence interval 95%		F	P-Value
				Upper limit	lower limit		
5>	93	58.97	16.770	62.42	55.51		
5-10	59	61.83	14.793	65.91	57.75		
10-15	40	63.15	15.772	98.19	58.11	27.265	0.01
15-20	15	67.80	13.576	75.32	60.28		
20-25	7	61.29	21.045	80.75	41.82		
25<	7	69.57	16.801	85.11	54.03		

Table5 *The relationship between marital status and the risk of MSDs in the upper limbs*

marital Status	Number of worker	Average score of posture	SD	Confidence interval 95%		T	P-Value
				Upper limit	lower limit		
Single	60	57.58	15.775	-0.628	-10.205	-2.247	0.770
Married	155	63	16.55	-0.639	-10.194		

Discussion

The results of Nordic Questionnaire showed that a large number of Seymareh hydropower plant workers complained of low back pain (48%). Comparing the results with general population, it can be seen that the workers complain was too high [19]. This study produced results which corroborate the findings of a great deal of the previous work in this area [18,20]. The incidence of knee and upper back symptoms were considerable. Awkward posture in a workplace is the main reason for these symptoms. Seymareh hydropower plant workers reported few symptoms associated with neck and leg symptoms. However, the findings of the current study do not support the previous research that reported the neck symptoms were common symptoms among subjects [21,22]. The results also showed that the incidence of wrist symptoms were 41%. The results of a study was conducted in hairdressers (Miri, 2008) indicated that

the incidence of wrist symptoms among hair dressers were 6% [23]. The finding of present study is in agreement with Yamalik's (2007) findings which showed that the wrist symptoms are frequent complains among dental hygienists [24]. The results showed that MSDs symptoms in the upper limbs increase with an increase in age. The highest score of posture was 69.04 in the age range of 41 to 50 years old. Posture score in the age range of 41 to 50 years old was slightly lower than that in 41 to 50 years old because of fewer workers in this age range. The present findings seem to be consistent with other research which found MSDs symptoms increases with age [25]. The results indicated that younger workers had fewer symptoms than older subjects but the number of workers in the 21 to 30 age group was higher than other groups. Also, hydropower plant workers with more job experience showed higher MSDs symptoms in the upper limbs. Workers with 15 to 20 years of job experience showed the frequent symptoms of MSDs but the most common symptoms were reported in workers with over 25 years of job experience. The results of some studies demonstrated that job experience is a risk factor for prevalence of MSDs in the workplaces [10,18].

Type of job is associated with MSDs symptoms in the upper limbs. Stunt box workers with 67.29 points got the highest posture score followed by drivers (65.60), kitchen workers (64), repair workers (63.70), welders (61.24), metal bar workers (60.32), hull cleaners (60), cement workers (59.97), dig and injection workers (57.42), concrete laboratory workers (54.31) and topographer (53.14). This finding accords with other observations, which showed that type of job had effect on MSDs symptoms and workers complains [18,26]. While, the result of Murtezani study (2010) showed that job tenure has less impact on low back pain sickness [27]. The results of QEC method showed that the level of exposure for 10.7% of workers was less than 40%. If the musculoskeletal exposure level is less than 40%, the risk level is acceptable. In 13% of the workers, the exposure level was between 41% and 50% indicated that modification measures are required (moderate risk). High exposure group (46.5%) had 51% to 70% exposure level (high risk). The level of exposure in 29.8% of workers was higher than 70% (very high risk) which indicated a need for immediate ergonomics intervention program. Duration of work, repetitive activities, body posture, standing, lifting a heavy load and physical work load are the main risk factors for MSDs in Seymareh hydropower plant workers that is in agreement with other studies in this field [3,5 and 28]. Physical exposure assessment in an Iranian rubber industry demonstrated that the level of exposure for 4.4% of subjects was less than 4o%, for 10.1% of subjects between 41- 50%, for 37.5% of workers between 51-70%, and in 48% of cases higher than 70% [19]. A comparison of the results in this study and the level of exposure in the rubber industry showed that the number of workers in high exposure group in this study was higher than those in the rubber industry. But the numbers of workers in very high exposure group exposure in rubber industry were higher than those in the current study. A considerable amount of literature has been published on the symptoms of MSDs and related risk factors. Several methods exist for assessing MSDs root causes. One of the most important methods for assessing the MSDs injuries in the upper limbs is QEC method used to identify the ergonomics risk factors in workplaces. QEC method determines the level of acceptable or unacceptable exposure. This method provides ways of determining corrective actions and control measures in job conditions.

Conclusion

A large number of workers complained of lower back pain. MSDs symptoms in the upper limbs increase with an increase in workers age. Workers with more job experiences showed higher MSDs symptoms in the upper limbs. Type of job is associated with MSDs symptoms in the upper limbs. Several workers experienced high level of physical exposure to ergonomic risk factors.

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Contributions

Study design: AMA, AHP, MK
Data collection and analysis: RF, SB.
Manuscript preparation: LO, SB

Conflict of interest

"The authors declare that they have no competing interests."

References

1- Ma L, Chablat D, Bennis F, et al. A new muscle fatigue and recovery model and its ergonomics application in human simulation. *Virtual Phys Prototyp*2010;5(3): 123-37.
2- Dehghan N, Choobineh A, Hasanzadeh J. Interventional ergonomic study to correct and improve working postures and decrease discomfort in assembly workers of an electronic industry. *Iran Occupational Health*2012;9(4): 71-9. [In Persian]
3- Choobineh A, Daneshmandi H, Aghabeigi M, Haghayegh A. Prevalence of musculoskeletal symptoms among employees of Iranian petrochemical industries: October 2009 to December 2012. *Int J Occup Environ Med*2013; 4(4): 195-204.
4- Monteiro J, Calvão J, Pinho M, et al. Ergonomic assessment of a workstation in a paints production line. *Occupational Safety and Hygiene II*2014: 193-4.
5- Yi J, Hu X, Yan B, et al. High and specialty-related musculoskeletal disorders afflict dental professionals even since early training years. *Appl Oral Sci*2013;21(4): 376-82.
6- Management and Planning Organization (I.R.I). Iran statistical year book. Tehran: The Organization; 2001.
7- Rahimi MS, Khanjani N. Evaluating risk factors of work- related musculoskeletal disorders in assembly workers of Nishabur, Iran using rapid upper limb assessment. *Journal of Health & Development*2012;1(3): 227-36. [In Persian]
8- Ariens GA, Bongers PM, Douwes M, et al. Are neck flexion, neck rotation, and sitting at work risk factors for neck pain? results of a prospective cohort study. *Occup Environ Med*2001; 58: 200–7.
9- Punnett L, Bergqvist U. Musculoskeletal disorders in visual display unit work: gender and work demands. *Occup Med*1999; 14: 113–24.
10- Nag A, Vyas H, Nag P. Gender differences, work stressors and musculoskeletal disorders in weaving industries. *Ind Health*2010; 48(3): 339-48.
11- Wijnhoven HA, De Vet HC, Picavet HSJ. Prevalence of musculoskeletal disorders is systematically higher in women than in men. *Clin J Pain*2006; 22(8): 717-24.
12- Bao S, Howard N, Spielholz P, et al. Two posture analysis approaches and their application in a modified rapid upper limb assessment evaluation. *Ergonomics*2007; 50(12): 2118-36.
13- Choobineh A, Tabatabaei SH, Behzadi M. Musculoskeletal problems among workers of an Iranian sugar-producing factory. *Int J Occup SafErgon*2009;15(4):419.
14- Li G, Buckle P, editors. A practical method for the assessment of work-related musculoskeletal risks-Quick Exposure Check (QEC). Proceedings of the human factors and ergonomics society annual meeting; 1998: SAGE Publications. PP: 1351-55.
15- David G, Woods V, Li G, Buckle P. The development of the Quick Exposure Check (QEC) for assessing exposure to risk factors for work-related musculoskeletal disorders. *Appl Ergon*2008;39(1):57-69.
16- Brown R, Li G. The Development of action levels for the "Quick Exposure Check "(QEC) System. *Contemporary Ergonomic*2003: 41-6.
17- Shafiezadeh K. Prevalence of musculoskeletal disorders among paramedics working in a large hospital in Ahwaz, southwestern Iran in 2010. *Int J Occupat Envir Med*2011; 2(3): 157-165.
18- Choobineh A, Tabatabaei SH, Mokhtarzadeh A, Salehi M. Musculoskeletal problems among workers of an Iranian rubber factory. *J Occup Health*2007; 49(5): 418-23.
19- Andersson GB. Epidemiological features of chronic low-back pain. *The lancet*1999; 354(9178): 581-5.
20- Alexopoulos EC, Stathi I-C, Charizani F. Prevalence of musculoskeletal disorders in dentists. *BMC Musculoskelet Disord*2004; 5(1): 16.
21- Merlino LA, Rosecrance JC, Anton D, Cook TM. Symptoms of musculoskeletal disorders among apprentice construction workers. *Appl Occup Environ Hyg*2003; 18(1): 57-64.
22- Dhimitri KC, McGwin Jr G, McNeal SF, et al. Symptoms of musculoskeletal disorders in ophthalmologists. *Am J Ophthalmol*2005; 139(1): 179-81.
23- Miri MR, Hosseini M, Sharifzadeh G. Evaluation of ergonomic postures of hairdressers by REBA in Birjand. *The Horizon of Medical Sciences*2008; 14(2): 39-44.
24- Yamalik N. Musculoskeletal disorders (MSDs) and dental practice part 2. Risk factors for dentistry, magnitude of the problem, prevention, and dental ergonomics. *Int Dent J*2007; 57(1): 45-54.
25- Roquelaure Y, Ha C, Leclerc A, et al. Epidemiologic surveillance of upper extremity musculoskeletal disorders in the working population. *Arthritis Rheum*2006; 55(5): 765-78.
26- Burdorf A, Sorock G. Positive and negative evidence of risk factors for back disorders. *Scand J Work Environ Health*1997; 23(4): 243-56.
27- Murtezani A, Hundozi H, Orovcanec N, Berisha M, Meka V. Low back pain predict sickness absence

among power plant workers. *Indian J Occup Environ Med*2010; 14(2): 49.
28- Habibi E, Asaadi Z, Khobi J, et al. Investigation of upper limb disorders and its relationship with physical working requirements among metallic industry workers. *Electronic Physician*2012; 4(2): 506-10.