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Investigation of Risk Factors of Work-Related Upper-Limb Musculoskeletal Disorders in a Pharmaceutical Industry

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Abstract: This study was performed among workers of an Iranian pharmaceutical industry with the aiming to determine WRMDs prevalence and exposure assessment of WRMDs risks. In this cross-sectional study, 84 female and male workers randomly selected from five packing operations. Modified Nordic Musculoskeletal Questionnaire (NMQ) was applied to study the prevalence of WRMDs and Rapid Upper Limb Assessment (RULA) method was used for the evaluation of the exposure to risk factors associated with work-related upper limb disorders. Results showed a significant association exists between neck, lower arm and A scores group with those obtained by self-reported pain ($p<0.01$). Similar RULA grand scores of 3 and 4 and action level of 2 were found for workers in five packing operations. Also, the results of this study revealed that RULA method is a fairly suitable tool for the evaluation of WRMDs among packing workers in pharmaceutical industry.

Key words: Upper-limb musculoskeletal disorders, RULA, NMQ, packing worker, risk factors

INTRODUCTION

Musculoskeletal disorders (MSDs) are a major cause of work-related disabilities and lost-time illnesses and injuries and disabilities in the both developed and industrially developing countries (Genaidy *et al*., 1993; Bernard, 1997; Maul *et al*., 2003; Choobineh *et al*., 2004; Pourmahabadian *et al*., 2005; Pourmahabadian and Azam, 2006). MSDs constitute a major proportion of all registered and/or compensable work-related diseases in many countries, representing a third or more of all registered occupational diseases in North America, the Nordic countries and Japan (Punnett *et al*., 2005). It has been estimated that 31% (1994) and 44% (1996) of all occupational illness in Finland and United States; respectively belong to work-related musculoskeletal disorders (WRMSDs) (Mattila and Vilkki, 1999).

It has been found that WRMSDs associated with numerous occupational risk factors, including physical work load factors such as force, posture, movement and vibration (Gerr *et al*., 1991; Burdorf, 1992; Kilbom, 1994), psychosocial stressors (Bongers *et al*., 1993; Bernard *et al*., 1994; Eklund, 1996) and individual factors (Armstrong *et al*., 1993) which are also known to be important as predictive variables. The level of exposure to physical workload can be normally assessed with respect to intensity (or magnitude), repetitiveness and duration. Various methods are now available for assessing exposure to the risks associated with work-related musculoskeletal disorders, or identifying potentially hazardous jobs or risk factors within a job. These include observational methods, instrumental or direct methods, self-reports and other psychophysiological methods.

In pharmaceutical industry, where pharmaceutics are packed, workers are involved in a fairly long hour of static work. In packing works, awkward posture and repetitive movements are very common. The majority of job activities are characterized by a sitting posture worker's head and trunk flexed forward and shoulders flexed and abducted. In this situation, high rate of WRMSDs occurrence could be expected

The aim of present study is to give (a) determination of WRMSDs prevalence rate among packing workers in antibiotic, tablet, syrup, ampoule and Povidione (as a antimicrobial agent) packing operations through using a modified Nordic Musculoskeletal Questionnaire (NMQ) (Kuorinka *et al*., 1987), (b) assessment of the level of workers' exposure to risk factors associated with work-related upper limb musculoskeletal disorders were examined by Rapid Upper Limb Assessment (RULA) (McAtmney and Corlett, 1993).

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MATERIALS AND METHODS

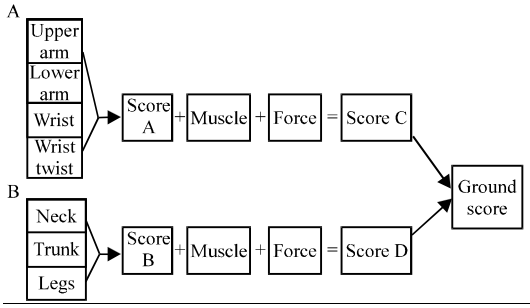
This cross-sectional study was performed in a pharmaceutical industry located in Tehran, Iran during 2006-2007. Totally, 950 male (66.7%) and female (33.3%) workers were employed in 3 units of pharmaceutics, hygienic products and administrative. In this study, 84 male and female workers from packing operations (Antibiotics, Tablet, Ampoule, Syrup and Povidone) were randomly selected and participated.

The prevalence of MSDs was obtained by using Nordic Musculoskeletal Questionnaire (NMQ) (Kuorinka *et al*., 1987). NMQ consisted of two parts and covered: a) personal details including sex, age, job experience, health and medical background and b) musculoskeletal problems in different body regions. Reported cases of MSDs among workers were identified and questioned from individuals or workers by considering period prevalence (12 months), point prevalence and intensity of musculoskeletal troubles (i.e., aches, pain, discomfort, numbness or tingling) in different anatomical areas (i.e., neck, shoulders, elbows, wrist/hands, upper back, lower back, hips/thighs/buttocks, knees and ankles/ feet) from NMQ.

Physical exposures to work-related musculoskeletal risks were assessed through using Rapid Upper Limb Assessment (RULA.), which is known as pen-paper observational method (McAtmney and Corlett, 1993). According to this method a score is calculated for the posture of each body part. A score of 1 indicated the best or most neutral posture, e.g., arms by the sides, elbows in approximately 90° flexion, wrists in neutral position, forearms mid-way between pronation and supination, neck in 10° flexion, trunk and legs sitting and well supported. A score of 4 indicated the worst position: e.g., shoulder flexion above 90° or flexion between 45° and 90° and abduction. The combined individual scores for shoulder, elbow and wrist gave score A and those for neck, trunk and legs gave score B. Muscle use and force exerted in each packing worker position were attributed a score of 1 and 0, respectively, because they are static postures without loading; these scores were added to scores A and B to obtain scores C and D, respectively (McAtamney and Corlett, 1993) (Table 1). Based on the design of the RULA method, each combination of scores C and D (a number of 1-7), called grand score and reflects the musculoskeletal loading associated with the worker's posture. Whereas low grand scores (of 1 or 2) indicate that the work posture is acceptable, action is suggested for the higher scores: further investigation and changes if required, for grand scores of 3 or 4; prompt investigation and changes for grand scores of 5 or 6 and immediate investigations and changes for a grand score of 7.

Collected data were analysed and compared statistically through using SPSS (Ver. 13). Chi-square and Fisher's exact tests ($p<0.05$ as significance limit) were implied to assess association between personal and work variables with self-reported musculoskeletal disorders.

Table 1: The RULA scoring sheet



The RULA method scoring sheet as described by McAtamney and Corlett (1993)

RESULTS AND DISCUSSION

As shown in Table 2, the prevalence of the reported pain in upper back is higher (54.8%) and for thighs is lower (26.2%). In addition, in tablet packing, the prevalence rate of upper back is higher (19%) than the other packing operations (Table 3).

Significant association is observed between reported pain and jobs for all body regions except for elbows ($p = 0.18$) and ankle ($p = 0.07$) as shown in

Table 2: Mean and standard deviation of age and job experience of the packing workers participated in sex groups (n = 84)

	Age (year)			Job experience (year)			
Sex	Mean±SD	Min	Max	Mean±SD	Min	Max	n (%)
Female	42.7±8.2	29	60	18.1±5.9	7	28	36 (42.9%)
Male	41.9±7.0	24	55	16.8±6.6	3	30	48 (57.1%)
Total	42.3±7.5	24	60	17.3±6.3	3	30	84 (100%)

SD = Standard Deviation

Table 3: Frequency of the reported pain between different job categories among packing workers by sex group (n = 84)

	Job category											
	Povidone		Ampoule		Syrup		Tablet		Antibiotic		Total	
Body parts	%	n	%	n	%	n	%	n	%	n	%	n
Neck	2.4	2	2.4	2	10.7	9	16.7	14	9.5	8	41.7	35
Shoulders	4.8	4	1.2	1	8.3	7	16.7	14	9.5	8	40.5	34
Elbows	1.2	1	1.2	1	8.3	7	8.3	7	3.6	3	22.6	19
Wrist/hands	3.6	3	2.4	2	14.3	12	17.9	15	11.9	10	50.0	42
Upper back	4.8	4	4.8	4	16.7	14	19.0	16	9.5	8	54.8	46
Low back	2.4	2	2.4	2	13.1	11	17.9	15	11.9	10	47.6	40
Thighs	3.6	3	1.2	1	4.8	4	11.9	10	4.8	4	26.2	22
knee	7.1	6	2.4	2	9.5	8	17.9	15	6.0	5	42.9	36
Legs	2.4	2	1.2	1	7.1	6	11.9	10	8.3	7	31.0	26
Ankle	4.8	4	3.6	1	8.3	7	10.7	9	8.3	7	33.3	28

Table 4. The Pearson chi-square and Fisher's exact tests as presented in Table 5 shows that there are significant association between sex and reported pain among packing workers in neck, shoulders, thighs and legs ($p<0.05$), but no significant association was found for wrist/hands, upper back and ankle. The P^2 statistical test was used to determine association between the subject's score defined by this grouping and any reported pain, ache or discomfort from that body part region. The results are given in Table 6 and demonstrates that there are significant association between the individual RULA body part scores (1 and/or >1) and the reported pain or discomfort for the neck, lower arm, wrist/hands scores and score A ($p<0.01$) and not significant for the trunk, upper arm scores as well as score B. The statistical significance of the neck, lower arm, body part scores as well as score A reflects the high loading of these body regions while performing a packing-based task. Finally, Table 7 presents the results of the physical exposure risk assessment by RULA and shows the grand score is between 3 and 4 for all packing workers and indicates that the level of exposure to musculoskeletal risks is needed to be considered (action level 2).

A population of 84 female and male packing workers who worked on 5 different packing operations in a pharmaceutical industry were studied by NMQ and RULA. The self-reported questionnaire results showed that musculoskeletal disorders were common among packing workers. Upper back, wrists/hands, low back, knees, neck and shoulders symptoms were found to be most prevalent problems among workers, respectively. Functionally, the neck-shoulder region experiences static muscle fatigue contributed to by the load of the arms and their position. The lower arm region includes the muscles

Table 4: Statistical analysis of the reported pain and jobs among packing workers n = 84)

	Job category											
	Antibiotic		Tablet		Syrup		Ampoule		Povidone		Pearson Chi-Square test	
	Pain		Pain		Pain		Pain		Pain			P^2
Body part	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	p	df = 4
Neck	8	4	14	6	9	15	2	10	2	14	0.001	18.55
Shoulders	8	4	14	6	7	17	1	11	4	12	0.001	18.66
Elbows	3	9	7	13	7	17	1	11	1	15	0.183	6.23
Wrist/hands	10	2	15	5	12	12	2	10	3	13	0.00	21.92
Upper back	10	2	15	5	11	13	2	10	2	14	0.00	24.67
Low back	8	4	16	4	14	10	4	8	4	12	0.008	13.90
Thighs	4	8	10	10	4	20	1	11	3	13	0.045	9.75
Knee	5	7	15	5	8	16	2	10	6	10	0.012	12.88
Legs	7	5	10	10	6	18	1	11	2	14	0.009	13.42
Ankle	7	5	9	11	7	17	1	11	4	12	0.07	8.66

Table 5: Statistical analysis between Sex and reported pain among packing workers by sex group (n = 84)

				Statistical test		
		Sex		Fisher's exact test	Pearson Chi-Square test	
Body part	Pain	Female	Male	p	p	P^2
Neck	No	14	35	0.003	0.002	9.80 (1df)
	Yes	22	13			
Shoulders	No	15	35	0.007	0.004	8.34 (1df)
	Yes	21	13			
Elbows	No	23	42	0.01	0.01	6.55 (1df)
	Yes	13	6			
Wrist/hands	No	16	26	0.51	0.38	0.78 (1df)
	Yes	20	22			
Upper back	No	16	28	0.27	0.20	1.59 (1df)
	Yes	20	20			
Low back	No	17	21	0.83	0.75	0.10 (1df)
	Yes	19	27			
Thighs	No	22	40	0.02	0.02	5.25 (1df)
	Yes	14	8			
Knee	No	17	31	0.12	0.11	2.53 (1df)
	Yes	19	17			
Legs	No	18	40	0.002	0.001	10.70 (1df)
	Yes	18	8			
Ankle	No	20	36	0.10	0.61	3.50 (1df)
	Yes	16	12			

Table 6: P^2 statistical analysis of the RULA body part scores (1 or > 1) and the reported pain, ache or discomfort in the region (n = 84)

		Posture score			
Body part	Pain	1	>1	P^2; df =1	p
Neck	No	19	30	3.69	0.001
	Yes	21	14		
Trunk	No	7	31	0.96	0.325
	Yes	5	41		
Upper arm	No	12	38	0.49	0.486
	Yes	6	28		
Lower arm	No	31	19	13.38	0.000
	Yes	4	30		
Wrist/hands	No	30	12	0.20	0.65
	Yes	4	38		
Group A	No	16	20	10.86	0.001
	Yes	6	42		
Group B	No	2	16	0.004	0.951
	Yes	7	59		

Table 7: Posture evaluation by the RULA technique among packing workers in different packing operations by sex group (n = 84)

	Grand score								
	3				4				
	Female		Male		Female		Male		
Type of packing operation	n	(%)	n	(%)	n	(%)	n	(%)	Action level
Antibiotic	4	4.8	3	3.6	4	4.8	1	1.2	2
Tablet	1	1.2	4	4.8	6	7.1	9	10.7	2
Syrup	16	19.0	0	0.0	6	7.1	2	2.4	2
Ampoule	4	4.8	8	9.5	0	0.0	0	0.0	2
Povidone	11	13.1	5	6.0	0	0.0	0	0.0	2

and associated soft tissue structures responsible for the posture and action of the wrist, hand and fingers. High rate prevalence of the upper back could be related to the long awkward posture of this region and lack of use of backrest while working. It is found that there is a significant association between sex and reported musculoskeletal disorders and showed that the obtained results are in agreement with many other studies such as (Chiang *et al*., 1993; Bernard *et al*., 1994; Hales *et al*., 1994).

Also, the results of this study indicated age and job experience were not significantly associated with musculoskeletal disorders and revealed that they are in good agreement with other studies (Wiseman and Badger, 1976; Berg *et al*., 1988; Burt *et al*., 1990).

Comparison the RULA results with those obtained through NMQ showed a significant association between neck, lower arm and score in group A and reported pain in that regions and agree with the findings of previous researches (McAtmney and Corlett, 1993; Tuzun *et al*., 1999; Paquet *et al*., 2001; Massaccesia *et al*., 2003). But, no significant association found between RULA scores and reported pain in trunk, upper arm, wrist/hands and score B and it is showed that they are fairly in line agreement with similar findings (Massaccesia *et al*., 2003; McAtmney and Corlett, 1993).

In this study, the RULA grand score was between 3 and 4 and indicating that the level of exposure to musculoskeletal risks needed to be considered (action level 2). Similarity in packing tasks and no requirements for high muscle force for packing small cases could be the reason for obtaining the same action level for all packing workers in the present study. However, by considering the obtained RULA and NMQ results in this study, major risk factors that workers are encountered could be due to awkward working postures and static work.

CONCLUSION

This study highlighted the RULA method allowed to perform a rapid and fairly correct evaluation tools for packing workers and evidenced that in the posture adopted in this type of job was associated with a major risk for back, neck, lower arm and postural problems could be largely caused by improper workstation furniture design. Ergonomic interventions through corrective measures could be taken into account for reducing exposure level and consequently preventing WRMSDs is highly recommended by performing workers training on working posture, administrative measures for establishing work-rest cycle, using proper seats which equipped with backrest together with reducing the height of working table in accordance to anthropometric data.

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