Biotech Health Sci. 2018 February; 5(1):e13599.

Published online 2018 February 1. **Research Article**

Subjective workload and musculoskeletal disorders among workers of a manufacturing company in Iran

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Received 2017 May 17; **Accepted** 2017 September 18.

Abstract

Background: One of the main factors for the health and safety issues is workload management. High workload in addition to health and safety problems such as Work-related Musculoskeletal Disorders (WRMSDs), can affect the quality and quantity of the tasks and leads to performance organizational losses finally.
Objectives: The aim of our research was to determining the Relationship between Workload and Musculoskeletal Disorders (as dependent factor) among Workers of an Automotive Components Producer Company in one of the central provinces of Iran, 2016.
Patients and Methods: This study was a cross-sectional study. All operating personnel (n= 170) was considered. Based on the exclusion criteria 107 workers were selected finally. Three questionnaires were used in this study: demographic, the body map (for WRMSDs measurement) and NASA-Task Load Index (TLX) for workload assessment. The collected data were analyzed using SPSS-V20.
Results: The prevalence of WRMSDs among the studied workers over the last 12 months was 53.3%. Workload score was calculated equals to 76.82±16.30. A significant relationship was observed between mental load with neck (P=0.026) and frustration with neck (P=0.023), upper back (P=0.049) and lower back (P=0.04) pain. On the other hand, based on our finding it is revealed that one score increase in mental workload score leads to increasing equals to 6.5% in the WRMSDs.
Conclusions: It was revealed that workload was high in the studied company. Hence the effective programs to mitigate and reducing the workload in order to ergonomic disorder management would be necessary.

Keywords: Ergonomic disorders, Workload, Manufacturing Company, NASA-TLX

1. Background

Based on the last experiences if policy makers and employers do not pay attention to health of the human resources, workplaces (especially office works) become one of the most hazardous places for employees as well as organizations encounter to great costs (1). Hence, maintaining and improving the health and safety of employees in the workplace is the most important responsibility of managers. In the 20th century, disorders, errors and stresses are related to physical environment merely but it is revealed that psychosocial and organizational are associated to occupational injuries and diseases too. Factors such as work cognitive demands, temporal pressure or demands and effort demands are categorized in psychosocial and organization field. All of these factors that can influence to think-based information processing, decision making and reaction to environment named mental workload (2). Mental workload was introduced by NASA researchers primarily (3-5). Physical demand can leads to musculoskeletal disorders (MSDs), in the other hands mental pressures or demands can leads to work-related stress and burnout too. According to previous studies, MSDs costs in Iran in 2000 were estimated near the 0.1% of the annual Iranian government Budget (1). It should be noted that that psychosocial and organizational factors are most important element on this issue (6).

Based on these facts recognition and control of workload factors should be considered in different workplaces. Ergonomics or human factor engineering is one of the most important scientific fields that can help managers to controlling of the workplace conditions (7). One of the main causes of human errors and reducing the work quality and efficiency is unsuitable workload for employees. Recognition of workload elements is the key factor for reducing work-related accidents and injuries as well as loss and cost management.

In the industries such as automotive parts producer companies' various heavy tasks with different demands are defined. Hence workload that imposes to workers is high (8). However, fatigue, human errors and physical pain can arise from high workload. In addition, we can experience job dissatisfaction in this situation. In a study

that was conducted in Finland by Gyekye (9) it is revealed that employees who had less job satisfaction, had experienced more accident, errors or incident as well as occurred accidents for them were more severe (10). A previous study was showed that some aspects of workload have been linked to job satisfaction (8).

2. Objectives

The aim of the our research was to determining the Relationship between Workload and Work-related Musculoskeletal Disorders among Workers in an automotive part Producer Company located at the one of the central provinces in Iran, 2016.

3. Methods

This cross-sectional study was conducted among all the operating personnel in an automotive parts producer company (n = 170). Exclusion criteria were included as: a) having lowest than one year working experience and b) having not related MSDs with their jobs. Based on the exclusion criteria were selected 107 workers finally. The research instruments were demographic questionnaire, the body map and the workload NASA-TLX questionnaire (paper and pencil version). The first questionnaire was included work experience, education, gender, marital status, and age. The NASA Task Load Index (NASA-TLX) is a simple evaluation method. NASA-TLX originally consisted of two parts: the total workload is divided into six subscales that are represented on a single page, serving as one part of the questionnaire: mental demand, physical demand, temporal demand, performance, effort, and frustration. There is a description for each subscale that the subject should read before rating. They are rated for each task within a 100-points range with 5-point steps. These ratings are then combined to the task load index. Then, a 15 pairwise selection of demands was used. Combining two steps scores will provide total score of workload (11). Providing descriptions for each measurement can be found in Table 1. The validity and reliability of the NASA-TLX was confirmed by previous studies (α=0.897) (12).

The third questionnaire (body map) was applied for identification of musculoskeletal pains as dependent variable (13). All questionnaires were completed by interview. Normality of the gathered data was analyzed by Shapiro-wilk test. Obtained data about workload and MSDs for each subjective was analyzed by SPSS version 20 aided by Mann-Whitney tests, Kruskal-Wallis and Poisson regression analysis.

4. Results

Among studied subjects were existed only two women and the rest men. The majority were married (81.3%) as well as in the diploma level or less (71.9%). Also over half of the participants were in the age group 18-29 years. Additional information regarding qualitative and quantitative demographic data was presented in Table 2 and above part of Table 4 respectively.

The prevalence of MSDs among the studied workers over the last 12 months was 53.3%. Based on the body map results, lower back pain with a 20.6% was the most problem and pain in the right forearm with 0.9% was in the lowest rate (Table 3).

Workload score was calculated between 8.66 as lowest and 100 as highest score with mean and standard deviation equals to 76.82±16.30. Among NASA-TLX six subscales, performance with the mean score of the 83.04 was as highest and fatigue with an average of the 27.38 was the lowest subscale. Descriptive information about all items was shown in Table 4.

Based on the normality test (Shapiro-Wilk) it is revealed that workload and its components data were not normal. We used Mann-Whitney test to assess relationship between workload and its subscales with MSDs in 17 parts of the body. This assessment revealed that neck pain was related with mental workload (P=0.026) and Frustration (P=0.023) significantly. Also left arm pain was related with physical workload (P=0.034) as well as upper back pain (P=0.049) and lower back pain (P=0.04) were related with frustration significantly. Kruskal-Wallis test showed that the physical demand and left ankle pain among various jobs was significant (P<0.05). The effects of various factors on WRMSDs using Poisson regression models were analyzed finally. Related results were shown in Table 5.

Table 1. Descriptions of NASA-TLX six subscales

Subscale title	Endpoint	Descriptions
Mental Demand	Low/high	How much mental and perceptual activity was required? Was the task easy or demanding, simple or complex?
Physical Demand	Low/high	How much physical activity was required? Was the task easy or demanding, slack or strenuous?
Temporal Demand	Low/high	How much time pressure did you feel due to the pace at which the tasks or task elements occurred? Was the pace slow or rapid?
Overall Performance	Good/poor	How successful were you in performing the task? How satisfied were you with your performance?
Frustration Level	Low/high	How irritated, stressed, and annoyed versus content, relaxed, and complacent did you feel during the task?
Effort	Low/high	How hard did you have to work (mentally and physically) to accomplish your level of performance?

Table 2. Qualitative demographic factors description (n=107)

Factor		Frequency	%
Gender	Male	105	98.1
	Female	2	1.9
Marital status	Married	87	81.3
	Single	20	18.7
Education	Diploma or lower	77	71.9
	Associate's degree	6	5.6
	Bachelor	24	22.4
Age	18-29	53	50.5
	30-40	40	38.1
	More than 40	12	11.4
Job	QC	3	3.7
	Line Operation	66	81.5
	Administration	3	3.7
	Supervising	7	8.6
	Engineering	2	2.5
WRMSD	No	57	53.3
	Yes	50	46.7

Table 3. Description of WRMSDs in various parts of the body (n=107)*

Part of the body	R. Ankle	L. Ankle	R. Thighs / hips	L. Thighs / hips	R. Hand	L. Hand	R. Bottom	L. Bottom	R. Elbow	L. Elbow	Lower back	R. Arm	L. Arm	Upper back	R. Shoulder	L. Shoulder	Neck
Frequency	8	4	18	18	10	9	8	6	1	5	22	5	2	20	12	12	13
%	7.5	3.7	16.8	16.8	9.3	8.4	7.5	5.6	0.9	4.7	20.6	4.7	3.33	18.7	11.2	11.2	12.1

*R: Right, L: Left

Table 4. Description of workload and its subscales (n=107)

Items/subscales	Min	Max	Mean	Std. Deviation
Work Experience	1	25	6.4	4.97
Training courses	0	6	1.35	1.36
Mental demand	0	100	76.03	28.16
Physical demand	0	100	68.17	29.78
Temporal demand	0	100	71.65	27.44
Performance	0	100	83.04	19.55
Effort	0	100	80.98	22.29
Frustration	0	100	27.38	30.37
Total workload	8.66	100	76.82	16.30

Table 5. Poisson regression results to finding related factors with WRMSDs

Parameter	Class	WRMSDs		
		Sig.	Std. Error	Exp(B)
Training	-	0.001	0.227	-0.762
Work Experience	-	0.152	0.216	-0.309
Education	Diploma or lower	0.92	1.448	-0.145
	Associate's degree	0.02	1.165	2.66
	Bachelor or higher		Reference	
Marriage status	Single	0.004	1.184	3.43
	Married		Reference	
Age	18-30	0.127	2.10	-3.21
	31-40		Reference	
Job	QC	0.473	1.8032	1.295
	Line Operation	0.108	2.6945	4.325
	Supervising	0.123	2.3505	3.622
	Engineering		Reference	
Mental demand	-	0.003	0.0223	0.065
Physical demand	-	0.904	0.0148	-0.002
Temporal demand	-	0.279	0.0111	-0.012
Performance	-	0.029	0.0362	-0.079
Effort	-	0.595	0.0246	0.013
Frustration	-	0.161	0.0156	-0.022

5. Discussion

More than half of the subjects in this study (53.3%) have been experienced musculoskeletal disorders during the past year. It seems awkward posture, lifting heavy loads and long-term shifts are the main causes of pain in the parts of body (14). In the studied industry, it was observed in spite of the low weight of each manufactured part but the workers collected manufactured parts in baskets and then carry alone in poor postures. Among the examined musculoskeletal disorders, neck pain outweighed the others. This finding is in line with a large number of similar studies in various managerial, industrial, service, health, education and military jobs (15-17). Regarding the relationship between skeletal and muscular pains and work absence (18), it seems that, considering correction of employees' activities conditions can lead to higher productivity.

The mean workload of the participants in this study was 76.82±16.30 that indicates a high level of workload. The calculated mean in the present study was lower than the results of other researchers in the activities and professions such as steel (19, 20) and was similar to occupations and activities like complex missions of emergency staffs (2), medical students (21), assembly workers in an automobile company (22), nursing (23), textile (24) and was higher than the calculated average for teachers (25), nurses (26), pilots training by simulators (27) and aircraft maintenance workers (28). One reason for the different results in the same occupational groups (e.g. nurses) can be referred to different types of defined tasks for studied occupational groups. Based on the results illustrated in the table 4, two dimensions of performance and effort were calculated at the highest level. Findings of Mazloumi and colleagues (22) around the performance, Hughes (29) about the effort, Sarsangi and colleagues (26) in the effort, Kazemi, et al (30) in the effort and Giahi and colleagues (31) about the effort were in line with this study. However, some studies mentioned mental dimension of workload as the highest calculated one (23, 32-35). The reason for this difference goes to the special physical and mental needs of each job.

Results of the study depicted that musculoskeletal disorders and workload were significantly associated ($P < 0.05$). Previous studies have also proved that relationship (19, 31, 35, 36). Regarding the high workload and musculoskeletal disorders in this study and on the other hand, the role of workload in physical and psychological stresses the importance of considering the workload is obvious. The relationship between workload and job satisfaction have been documented in a study (37). Therefore, job satisfaction and then organizational productiv-

ity would improve through optimizing the load on employees.

According Poisson regression test results in table 5, increasing the numbers of training courses on ergonomics was resulted 76.2% reduction in the number of WRMSDs. If applied courses and in line with the type of tasks could be defined and given, would help to modify behaviors and adjust psychological and social challenges in the workplace. One more thing, responders with associate degree experienced musculoskeletal problems 2.66 times more than their counterparts with bachelor's degree or higher. Applying ergonomics principles and behavior modification because of higher level of knowledge as well as reducing the physical load imposed on people with higher educational degree can be the reasons for this difference. Single people also had this group of disorders 3.43 times more than marrieds. It seems that emotional support from family could be considered as a factor to adjust workloads and behaving safer. Furthermore, the results showed that one score increase in the mental demand lead to 6.5% increase in WRMSDs. Also, an increase in the performance dimension decrease 9.7% in musculoskeletal disorders. On this basis, job satisfaction is an important factor in reducing ergonomic disorders.

5.1. Conclusion

Generally, regarding the high prevalence rate of musculoskeletal disorders and workload in this study, engineering and administrative controls should be applied to control the workload on the workers. Both macro and micro approaches can be considered in correction programs.

Authors' contributions

ARK & MK conceived of the study, and participated in its design. FM, EK and SM carried out the data gathering & entry, as well as ARK & MK drafted the manuscript. All authors read and approved the final manuscript.

Funding/Support: All financial support was provided by the research deputy of Qom University of Medical Sciences.

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