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Can Educational Intervention be Useful in Improvement of Body Posture and Work Related Musculoskeletal Symptoms?

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ABSTRACT

Background: Poor postures are an important risk factor for work-related musculoskeletal disorders. The present study aimed to assess the impact of educational interventions on the correction of body posture and reducing work-related musculoskeletal disorders (WMSDs) in assembly line workers.

Methods: This interventional study was conducted on 63 assembly line workers. Data collection tools were demographic questionnaire, Cornell Musculoskeletal Discomfort Questionnaire (CMDQ), and Rapid Upper Limb Assessment (RULA). Data were collected before the two-day educational intervention and two months after the training. Data analysis was performed using descriptive statistics and Wilcoxon test.

Results: The prevalence of WMSDs was 85.7% before the intervention, which reduced to 46.7% after the intervention. Discomfort symptoms were higher in the neck, lower back, upper back, and wrists compared to the other body parts. RULA action level decreased significantly after the intervention ($P < 0.001$). Moreover, the frequency, severity, and impact of pain in the neck, lower back, upper back, and wrists on the tasks of the subjects reduced significantly after the intervention.

Conclusion: Educational intervention is an effective solution to reduce the prevalence, frequency, severity, and impact of pain on the ability and body posture of workers, but multi-component, ergonomic interventions should be implemented to achieve better outcomes.

1. Introduction

Musculoskeletal disorders are the abnormalities that affect the muscles, bones, joints, blood vessels, and nerves [1]. These disorders are characterized by various symptoms, such as stiffness, numbness, pain, and weakness [2]. Work-related musculoskeletal disorders (WMSDs) challenge the health of workers in every industry among the most common occupational illnesses [3,4].

The risk of WMSDs is higher in some professions considering the involved risk factors, presenting an important ergonomic issue [1,5]. WMSDs are the main health problems in industrial workers and ergonomists [6,7]. In Europe, WMSDs have been reported to affect 45 million employees [5]. These disorders may reduce productivity and quality, leading to economic and social consequences [8]. Therefore, adequate studies are required in order to prevent and decrease the risk of these disorders.

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Lower back, neck, shoulder, hand, elbow, and wrists are the body parts that are more affected comparatively [8].

Several factors could cause musculoskeletal disorders, including poor posture, repetitive movement, and force [2, 5, 9]. Inappropriate postures (deviation of the body parts from their natural position while performing a task) are the most common physical factors affecting workers [10]. Sustained posture is also associated with WMSDs [11]. Poor postures are an important cause of back pain and health problems [9]. Physical risk factors (e.g., poor posture) could lead to various complications in assembly line workers [5].

Assembly lines cause numerous health risks and WMSDs, especially in the upper limbs [11]. In some countries, the automotive assembly is an important industry, which exposes workers to the poor postures leading to WMSDs due to the nature of the tasks [9,12]. Ergonomic interventions in the workplace should be aimed at correcting working postures, which suggest changing the patterns of performing duties in workers [7, 13].

Prevention and reduction of WMSDs are challenging issues [14]. Ergonomic interventions could positively influence working postures and are considered to be an optimal strategy [8, 15]. Improved ergonomics have the potential to achieve better musculoskeletal health, which is the main objective of the discipline [7]. Education and training of workers on proper work practice is a possible intervention in this regard [2].

Findings have indicated that educational interventions are effective in reducing the intensity of WMSD syndromes through enhancing several factors, such as working postures; however, the control groups in the related studies have been reported to have higher WMSD rates [14, 15]. According to the literature, such interventions could effectively decrease WMSDs in the workplace despite the discrepancies in the obtained results. On the other hand, educational interventions via back school and neck school have not been effective in the short-term improvement of musculoskeletal health [7].

In a study, Rasotto et al. concluded that physical activity programs could reduce the signs of pain in the neck, shoulders, elbows, and wrists in metal industry workers [16].

Similarly, Arabian et al. (2013) claimed that educational interventions alone cannot result in significant improvements in this regard [17]. Furthermore, it has been demonstrated that poorly implemented interventions are not sufficient to prevent WMSDs [14]. Mohammadi Zeydi et al. have also denoted that theoretical ergonomic interventions might be useful in the improvement of body postures in computer operators [18].

Adoption and implementation of proper strategies are required for the development of proper interventions in this regard. The present study aimed to assess the effectiveness of educational interventions in the correction of poor body postures in assembly line workers and determine whether WMSD symptoms could reduce significantly after the intervention.

2. Materials and Methods

2.1. Study Design

This quasi-experimental study was conducted on all the assembly line workers in an automobile accessories industry in 2017. The inclusion criterion was the willingness of the workers to participate in the study, and the exclusion criteria were the presence of contextual musculoskeletal problems and work experience of less than one year. In total, 13 workers were excluded, and 67 workers met the inclusion criteria. Among the eligible subjects, 63 workers completed the questionnaires (response rate: 94%).

2.2. Data Collection

consisting of data on the age, gender, work experience, weight, and height of the workers. The second tool was the Rapid Upper Limb Assessment (RULA) checklist, which was used to evaluate the posture of the subjects during work. RULA was developed to evaluate the individual exposure of workers to the ergonomic risk factors for upper-extremity musculoskeletal discomforts. In addition, this tool assesses the position of the upper and lower limbs, wrists, neck, trunk, and legs, muscle use, and load, generating an overall score. Scores 1-2 indicate negligible risk, scores 3-4 indicate low risk, scores 5-6 show moderate risk, and score 7 is indicative of the high risk of musculoskeletal disorders. Based on the scores, RULA proposes the action levels of one (no action required), two (changes may be required), three (further investigation/imminent change is required), and four (immediate improvement required) [19].

Another data collection tool in the present study was Cornell Musculoskeletal Discomfort Questionnaire (CMDQ) [20]. CMDQ was used to assess the prevalence, frequency (1-2 times per week, 3-4 times per week, once a day, and several times a day), severity (high, moderate, low) and impact of pain (none, low, and high) in participants. This tool has been tested in previous studies, and its validity and reliability have been confirmed for the Iranian worker population with 11 body parts. The scores in this scale were analyzed by counting the number of the symptoms per person [21].

2.3. Study Phases

The present study had three phases. In the first phase, a trained observer assessed the prevalence, frequency, intensity, and effect of WMSDs on pain in workers based on CMDQ and the body posture of each subject using the RULA checklist. All the subjects had a single task in assembly and were evaluated three times while working in their worst body posture.

The second phase of the study was the implementation of educational interventions. An experienced occupational health and ergonomics advisor instructed the workers on ergonomic principles, body posture, musculoskeletal pain and disorders, and methods to prevent injuries (e.g., appropriate

posture) in a two-day workshop (10 hours). The subjects had no prior participation in ergonomic education programs. Data obtained from the first phase of the study (images and films) were used to exhibit examples to the subjects and raising their awareness. In this intervention, the research team attempted to involve the workers actively, so that they could actualize the educational items.

The third phase of the study was similar to the first phase. The third phase was performed two months after the intervention in order to evaluate the impact of the educational contents on the health of the subjects. The mentioned interval was advised by health education experts to provide the time for behavioral changes in the workers.

All the study phases were implemented by the same investigator so as to prevent bias in the RULA scores.

2.4. Statistical Analysis

Data analysis was performed in SPSS version 22 using descriptive statistics (mean and standard deviation) to describe the demographic data. Moreover, Wilcoxon test was applied to determine the effectiveness of the educational intervention and differences in the RULA and CMDQ scores.

2.5. Ethical Considerations

The present study was conducted in accordance with research ethical principles. The study protocol was approved by the company managers, and participation in the research was voluntary. The personal information of the subjects remained confidential.

3. Results and Discussion

All the participants were male and worked daytime shifts only. Table 1 presents the demographic characteristics of the studied population.

Among the participants, 54 workers (85.7%) reported musculoskeletal discomfort in at least one part of the body. Neck (70%), upper back (62%), lower back (55%), and right wrist (52%) were the body parts with the highest prevalence of discomfort. Table 2 shows the frequency, severity, and impact of pain in the subjects before the intervention.

Two months after the educational intervention, the first phase was repeated. The prevalence of musculoskeletal discomfort was 47.6%. Neck (38%), right shoulder (35%), upper back (32%), and lower back (30%) were the body parts with highest prevalence of pain. Table 3 shows the frequency, severity and the impact pain in workers after intervention phase.

Wilcoxon test was used in order to the assessment of intervention effectiveness. There found that in 9 body parts the frequency, 11 body parts the severity, and in 10 parts, the impact of pain was significantly reduced. Furthermore, in all

body parts except the left upper arm, the prevalence of discomfort was reduced. Table 4 shows the Wilcoxon test results between before and after intervention phases.

Table 1: Demographics of studied workers

Demographics	Mean \pm SD
Age	32.5 \pm 6.86 (years)
Work Experience	6.06 \pm 5.40 (years)
Height	175 \pm 7.29 (Cm)
Weight	77.46 \pm 19.32 (Kg)
Demographics	Description Frequency (%)
Education level	Diploma: 43(68%), Academic: 20 (32%)
Marriage	Married: 45 (71.4%),
Body Mass Index (BMI)	Single 18 (28.6%)
Demographics	Underweight: 2 (3.2%)
	Normal: 33 (52.4%)
	Overweight: 18 (28.6%)

Wilcoxon test was used in order to the assessment of intervention effectiveness. There found that in 9 body parts the frequency, 11 body parts the severity, and in 10 parts, the impact of pain was significantly reduced. Furthermore, in all body parts except the left upper arm, the prevalence of discomfort was reduced. Table 4 shows the Wilcoxon test results between before and after intervention phases.

The comparison of frequency of RULA final scores before and after intervention showed significant difference ($P < 0.001$). Table 5 compares frequency of scores in two phases.

Finally, the recommended action level difference between the two phases was assessed with Wilcoxon test and revealed that the action level was lowered after intervention significantly ($P = 0.001$).

The aim of this study was to assess the impact of educational interventions on correction of the body posture and WMSDs symptoms in assembly line workers. We made the intervention by courses of ergonomics principles, the body posture, and WMSDs prevention. The results showed that in many parts of the body, the prevalence, frequency, severity, and impact of pain on the worker's task were decreased.

Furthermore, the final scores of the RULA checklist were decreased significantly among participants two months after intervention.

In this study, the prevalence of WMSDs before the intervention was 85.7%. This prevalence rate is lower than the results of Arghami et al. (2016) that reported WMSDs in assembly line women workers as 98% [6].

This difference can be due to the gender of workers. Guerreiro et al. (2017) reported this amount in an automobile assembly line factory as 68.5%, and Anita et al 78.4% in the same industry [9, 12]. The results show that the prevalence rate of WMSDs in assembly-line workers is high and there is a need for improvement.

Table 2: Prevalence, Frequency, Severity, and Impact of Pain before Intervention

Body Part	Pain Frequency					Pain Severity			Pain Impact on workers' work			Prevalence
	Never (No pain)	1-2 times a week	3-4 times a week	Once a day	Several times a day	Low	Mod	High	No	Low	High	Percentage
Neck	19	18	9	8	9	17	22	5	6	24	14	70%
Right Shoulder	37	8	7	6	5	7	16	3	3	15	8	41%
Left Shoulder	40	9	3	6	5	9	13	3	6	13	6	37%
Upperback	28	18	1	3	13	14	13	8	8	16	11	55%
Right Upperarm	48	7	3	4	1	7	7	1	4	10	1	24%
Left Upperarm	50	5	3	4	1	7	5	1	4	8	1	21%
Lower back	25	11	9	4	14	8	18	12	6	17	15	62%
Right forearm	44	6	3	3	7	4	11	4	1	10	8	30%
Left Forearm	44	8	2	2	7	6	9	4	1	10	8	30%
Right wrist	30	13	5	5	10	9	15	9	15	16	2	52%
Left wrist	35	9	6	3	10	9	12	7	4	21	3	44%
Hip	45	7	3	3	4	5	10	2	5	11	1	27%
Right Tight	50	5	2	4	2	9	3	1	7	3	3	21%
Left Tight	50	5	2	4	2	10	2	1	9	3	2	21%
Right knee	38	6	2	2	15	3	12	10	3	10	12	43%
Left knee	38	6	2	1	16	4	10	11	6	7	12	43%
Right lower leg	46	6	3	5	3	4	10	3	4	10	3	27%
Left lower leg	46	5	4	5	3	7	8	2	4	10	3	27%
Right foot	40	9	3	3	8	5	10	8	3	13	10	37%
Left foot	41	10	1	2	9	6	9	7	4	12	6	35%

The frequency, severity, and impact of the pain on worker's work were higher than the results of Aziz et al. (2017) [22]. This difference could be because of the nature of tasks, different organizational situation, and different workstations.

In this study, the prevalence of WMSDs in some parts of the body was higher than others (neck 70%, lower back 62%, upper back 55%, and Right wrist 52%). This result is similar to the results of Arghami et al. (2016) [4], Anita et al. (2014) [9], Aziz et al. (2017) [22], and Guerreiro et al. (2017) [12].

These results showed that the assembly-line workers experience similar risk factors and suffer from discomfort symptoms in the same body parts.

In fact, the origin of assembly work and its special demands cause the problems, and some body parts like back and upper limb are more susceptible to these types of discomforts. The prevalence of pain in different body parts was higher in this study, and this result could be due to work situation and lack of knowledge about ergonomics principles before the intervention.

Former studies have shown that awkward postures are as a main cause of health problems. Posture assessment using RULA method showed that all of the studied workers were at the risk of WMSDs. As RULA action level increases, the chance of WMSDs also increases [9]. So, postural loads need to be assessed.

Table 3: Prevalence, Frequency, Severity, and Impact of Pain after Intervention

Body Part	Pain Frequency					Pain Severity			Pain Impact on workers' work			Prevalence
	Never (No pain)	1-2 times a week	3-4 times a week	Once a day	Several times a day	Low	Mod	High	No	Low	High	Percentage
Neck	39	9	6	3	6	10	8	6	3	16	5	38%
Right Shoulder	41	9	4	4	5	8	11	3	4	15	3	35%
Left Shoulder	44	9	3	2	5	7	10	2	4	12	3	30%
Upperback	43	4	6	3	7	7	11	2	2	14	4	32%
Right Upperarm	47	12	0	1	3	7	6	3	5	8	3	25%
Left Upperarm	50	9	2	1	1	7	6	3	6	6	1	21%
Lower back	44	7	3	0	9	5	6	8	4	8	7	30%
Right forearm	50	5	1	3	4	3	6	4	3	3	7	20%
Left Forearm	51	6	1	2	3	6	3	3	4	3	5	19%
Right wrist	45	8	1	5	4	5	7	6	1	12	5	28%
Left wrist	49	5	1	4	4	4	6	4	2	7	3	22%
Hip	52	4	1	3	3	6	4	1	6	4	1	17%
Right Tight	55	4	1	0	3	3	3	2	1	5	2	13%
Left Tight	52	4	2	2	3	3	6	2	2	7	2	19%
Right knee	51	2	2	7	1	2	3	7	2	5	5	17%
Left knee	50	2	3	2	6	1	7	5	1	6	6	21%
Right lower leg	54	5	2	1	1	5	3	1	2	5	2	14%
Left lower leg	53	5	3	0	2	5	3	2	3	4	3	16%
Right foot	51	6	1	3	2	5	6	1	3	7	2	17%
Left foot	49	10	0	2	2	7	6	1	6	7	1	22%

Theoretical interventions can improve body postures [18]. Making the workers aware of the risk factors of WMSDs like awkward postures and learn them how to prevent them can reduce the prevalence, frequency, severity, and impact of the pain on worker's work. RULA final action level score was decreased significantly after the intervention. This result was similar to the result of Rafieepour et al. (2015), but other elements of workplace such as task and workstations are also important and can decrease the efficiency of ergonomic interventions [23].

The prevalence of WMSDs in workers reduced by 38.1% after implementation of the educational intervention (from 85.7% to 46.7%). Furthermore, the frequency, severity, and impact of pain were reduced in more than half of the studied body parts. This result is similar to the results of Rafieepour et al. (2015) [23] in the assessment of computer operators but different from the results of Arabian et al. (2013) [17]. Our finding supports the notion that effective intervention is not only engineering one [5]. Interventions are known as the best strategy to reduce the risk of WMSDs [8].

It is very important to diagnosis that how should be implementation of the interventional program. Furthermore, the quality of the intervention is of important. Engaging methods and active ones that highly involve the worker can have more positive results. In this intervention we tried to encourage workers to implement ergonomics principles during their work at their workstation, then we monitored them during 2 months. The cooperation and attention of workers to the training program was one of the reasons of reduced pain and symptoms. Westgaard et al. in a review on ergonomic interventions declared that organizational culture interventions with the high commitment of workers and employees, implementation of modifier interventions, and using multiple interventions have a high chance to success [13].

Teaching workers on how they can protect themselves against WMSDs risks can change their behaviors and reduce their symptoms. In contrast, some studies have claimed that using only educational interventions cannot be useful enough [17].

Table 4: Comparison of Pain Frequency, Severity, and Impact on Workers' Work before and after Intervention

Body Part	Pain Frequency (after vs before)	Pain Severity (after vs before)	Pain Impact on workers' work (after vs before)
Neck	0.006*	0.001*	$P < 0.001^*$
Right Shoulder	0.446	0.362	0.203
Left Shoulder	0.376	0.348	0.231
Upperback	0.045*	0.007*	0.01*
Right Upperarm	0.722	0.721	0.773
Left Upperarm	0.451	0.923	0.300
Lower back	0.004*	0.002*	0.001*
Right forearm	0.201	0.313	0.180
Left Forearm	0.114	0.079	0.048*
Right wrist	0.003*	0.001*	$P < 0.001^*$
Left wrist	0.003*	0.001*	$P < 0.001^*$
Hip	0.234	0.02*	0.053
Right Tight	0.227	0.662	0.500
Left Tight	0.756	0.547	0.717
Right knee	0.004*	0.008*	0.014*
Left knee	0.006*	0.010*	0.013*
Right lower leg	0.042*	0.041*	0.082
Left lower leg	0.074	0.140	0.133
Right foot	0.005*	0.002*	0.006*
Left foot	0.15	0.014*	0.007*

* $P < 0.05$

Table 5: The Comparison of RULA Scores before and after Intervention

RULA score	Action Level	Frequency (before)	Frequency (after)	P value (Wilcoxon test)
1	1	0	0	$P < 0.001$
2		0	11	
3		28	40	
4	2	14	11	
5		11	1	
6		6	0	
7	4	4	0	

Clearly multi-dimensional ergonomic interventions have a more probability of success in comparison to one-dimensional ones [15].

Workplace and task-related variables are important for the selection of intervention strategy to show how is possible to reduce risk factors. In the educational intervention, it is impossible to reduce task and workstation-related risk factors, so after the intervention still, 46.7% of workers reported discomforts. Education is a low-cost and rapid intervention and is applicable in any workplace. An educational intervention can have a very positive impact in reducing musculoskeletal discomforts if it can be implemented well, but it is not enough to eliminate all WMSDs symptoms. Some implications like selecting intervention based on problems and complaints of workers, making them aware from risk factors especially awkward postures and introduce them strategies to prevent WMSDs, using multi-dimensional interventions like using education and workstation related improvements, following up the workers behaviors and

teaching them to organize the workplace can be useful to reduce WMSDs symptoms. This study was not without limitations. Relative low sample size that was because of exclusion criteria. Future researches can consider the effect of each interventional program separately on workers and compare effectiveness of them.

4. Conclusion

According to the results, the prevalence of WMSDs was relatively high among assembly line workers. Educational interventions could effectively reduce these disorders if they are implemented and followed-up properly. In addition, raising the awareness of workers regarding proper postures and their role in preventing WMSDs could decrease the prevalence rate of these disorders, while it may not eliminate the symptoms completely. In order to achieve better outcomes, such educational interventions should be accompanied by the improvement of workstation and tasks.

Authors' Contributions

H.S., M.R., and R.K., designed the study and wrote the manuscript; E.B. and E.G. collected the data and conducted statistical analysis; H.S., E.B., and R.K. planned and conducted the intervention; and all authors revised and approved the final manuscript.

Conflict of Interest

There was not competing interests.

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