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

Hamidreza Samadi a | Matin Rostami b | Ehsan Bakhshi c | Ehsan Garosi d | Reza Kalantari b,*

a Department of Occupational Health Engineering, School of Public Health, Hamedan University of Medical Sciences, Hamedan, Iran.
b Department of Ergonomics, School of Public Health, Shiraz University of Medical Sciences, Shiraz, Iran.
c Islamabad-e Gharb Health Center Network Kermanshah University of Medical Sciences, Kermanshah, Iran.
d Department of Occupational Health, School of Public Health, Tehran University of Medical Sciences, Tehran, Iran.

*Corresponding author: Reza Kalantari
Department of Ergonomics, School of Public Health, Shiraz University of Medical Sciences, Shiraz, Iran, 7134567532.
Tel: +98- 9125420218.
E-mail address: rkalantari@sums.ac.ir

ARTICLE INFO

Article type: Original article

Article history:
Received January 28, 2018
Revised February 27, 2018
Accepted March 28, 2018

DOI: 10.29252/jhehp.4.2.7

Keywords:
WMSDs
Workers
Posture
Education
Assembly Line

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.

To cite: Samadi H, Rostami M, Bakhshi E, Garosi E, Kalantari R. Can Educational Intervention be Useful in Improvement of Body Posture and Work Related Musculoskeletal Symptoms? J Hum Environ Health Promot. 2018; 4(2): 81-6.
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 WMDS [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 WMDS, 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 WMDS 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 WMDS 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 WMDS syndromes through enhancing several factors, such as working postures; however, the control groups in the related studies have been reported to have higher WMDS rates [14, 15]. According to the literature, such interventions could effectively decrease WMDS 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 WMDS [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 WMDS 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

Data collection was conducted via back school and neck school. 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 WMDS 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.

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.
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 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 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           | 6                   | 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  | 12  | 10    | 37%         |
| Left foot        | 41                              | 10             | 1                          | 2          | 9                   | 6   | 9   | 7    | 4  | 12  | 6     | 35%         |

### 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                           | 0.682                           | 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                 |                        |
| 2          | 0            | 11                 |                   |                        |
| 3          | 2            | 28                 | 40                |                        |
| 4          | 3            | 14                 | 11                | P < 0.001              |
| 5          | 4            | 11                 |                   |                        |
| 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.

Acknowledgments

We wish to express our sincere thanks to the workers and company management who associated in this research.

References

1. Choobineh A, Soleimani E, Daneshmandi H, Mohamadbeigi A, Izadi Kh. Prevalence of Musculoskeletal Disorders and Posture Analysis Using RULA Method in Shiraz General Dentists in 2010. J Islam Dent Assoc Iran. 2013; 25(1): 35-40.
2. Faucett, J, Garry M, Nadler D, Ettere D. A Test of Two Training Interventions to Prevent Work-Related Musculoskeletal Disorders of the Upper extremity. Appl Ergon. 2002; 33(4): 337-47.
3. Silverstein B, Clark R. Interventions to Reduce Work-Related Musculoskeletal Disorders. J Electromyogr Kinesiol. 2004; 14(1): 135-52.
4. Arghami Sh, Kalantar R, Ahmadi Kionani E, Zanjirani Farahani A, Kamrani M. Assessing Prevalence of Musculoskeletal Disorders in Women Workers in an Automobile Manufacturing Assembly Line. J Hum Environ Health Promot. 2016; 1(2): 74-9.
5. Zare M, Bodin J, Cercier E, Brunet R, Roquelaure Y. Evaluation of Ergonomic Approach and Musculoskeletal Disorders in Two Different Organizations in a Truck Assembly Plant. Int J Ind Ergon. 2015; 50: 34-42.
6. Kalantar R, Arghami Sh, Ahmadi Kionani E, Garosi E, Zanjirani Farahani A. Relationship between Workload and Low back Pain in Assembly Line Workers. J Kermanshah Univ Med Sci. 2016; 20(1): 26-9.
7. Choobineh A, Tahatabaei SH, Mokhtarzadeh A, Salehi M. Musculoskeletal Problems among Workers of an Iranian Rubber Factory. J Occup Health. 2007; 49(5): 418-23.
8. Chiaisson MÈ, Imbeau D, Aubry K, Delisle A. Comparing the Results of Eight Methods Used to Evaluate Risk Factors Associated with Musculoskeletal Disorders. Int J Ind Ergon. 2012; 42(5): 478-88.
9. Anita A, Yazdani A, Hayati Kadir Sh, Adon MY. Association between Awkward Posture and Musculoskeletal Disorders (MSD) among Assembly Line Workers in an Automotive Industry. Malays J Med Health Sci. 2014; 10: 23-8.
10. Chander DS, Cavatorta MP. An Observational Method for Postural Ergonomic Risk Assessment (PERA). Int J Ind Ergon. 2017; 57: 32-41.
11. Da Costa BR, Vieira ER. Risk Factors for Work-Related Musculoskeletal Disorders: a Systematic Review of Recent Longitudinal Studies. Am J Ind Med. 2010; 53(3): 285-323.
12. Guerreiro M, Serranheira F, Cruz EB, Sousa-Uvd A. An Analysis on Neck and Upper Limb Musculoskeletal Symptoms in Portuguese Automotive Assembly Line Workers. Int J Occup Environ Saf. 2017; 1(1): 59-68.
13. Choobineh A, Motamedzade M, Kazemi M, Moghimbeigi A, Heidari Pahlavian A. The Impact of Ergonomics Intervention on Psychosocial Factors and Musculoskeletal Symptoms among Office Workers. Int J Ind Ergon. 2011; 41(6): 671-6.
14. Van Eerd D, Munhall C, Irvin E, Rempel D, Brewer S, Van der Beek AJ, et al. Effectiveness of Workplace Interventions in the Prevention of Upper Extremity Musculoskeletal Disorders and Symptoms: an Update of the Evidence. Occup Environ Med. 2016; 73(1): 62-70.
15. Esmaelizadeh S, Oxn C, Capan N. Effects of Ergonomic Intervention on Work-Related Upper Extremity Musculoskeletal Disorders among Computer Workers: A Randomized Controlled Trial. Int Arch Occup Ergon Environ Health. 2014; 87(1): 73-83.
16. Rasotto C, Bergamin M, Simonetti A, Maso S, Bartolucci GB, Ermolao A, et al. Tailored Exercise Program Reduces Symptoms of Upper Limb Work-Related Musculoskeletal Disorders in a Group of Metalworkers: A Randomized Controlled Trial. Manual Therapy. 2015; 20(1): 56-62.
17. Arabian FA, Motamedzade M, Golmohammadi R, Moghimbeigi A, Pir Hayati F. The Impact of Ergonomics Intervention on Musculoskeletal Disorders among Nahavand Alimoradian Hospital Staff. J Ergon. 2013; 1(1): 23-32.
18. Mohammidi ZI, Morshed H, Mohammadi ZB. Effectiveness of a Theory-Based Educational Intervention on Modifying Body Posture of Computer Users in Iran. J Rafsanjan Univ Med Sci. 2012; 11(2): 145-58.
19. McAtamney L, Corlett EN. RULA: A Survey Method for the Investigation of Work-Related Upper Limb Disorders. Appl Ergon. 1993; 24(2): 91-9.
20. Cornell University Ergonomics Web. Available from: URL: http://ergo.human.cornell.edu/ahmsquest.htm.
21. Afifezadeh-Kashani H, Choobineh A, Bakand S, Gohari MR, Abbastabar H, Mostaghfi P. Validity and Reliability of Farsi Version of Cornell Musculoskeletal Discomfort Questionnaire (CMDQ). Ir J Occup Health. 2011; 7(7): 69-75.
22. Aziz FA, Ghazalli Z, Mohamed NMZN, Isfar A, Mohd Shalahim NS. G3-4 Musculoskeletal Discomfort among Assembly Team Members performing Assembly Welding Task. Japanese J Ergon. 2017; 53(Supplement2): S466-S469.
23. Rafieepour A, Rafieepour E, Saleghian M. Effectiveness of Ergonomics Training in Decreasing the Risk of Musculoskeletal Disorders Based on Rapid Upper Limb Assessment among Computer Operators. J Ergon. 2015; 3(1): 25-32.