



## Effect of Education on Reducing Ergonomic Risk in Traditional Carpet Weavers Working in Workshops in Golestan Province, Iran; an Interventional Study

### ARTICLE INFO

#### Article Type

Original Research

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#### How to cite this article

Gholami A, Teimori Boghsani G H, Fouladi Dehaghi B, Tamaddon Yalameh J. Effect of Education on Reducing Ergonomic Risk in Traditional Carpet Weavers Working in Workshops in Golestan Province, Iran; an Interventional Study. International Journal of Musculoskeletal Pain Prevention. 2018 ;3(1):29-34.

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#### Article History

Received: November 25, 2017  
Accepted: February 11, 2018  
ePublished: March 20, 2018

### ABSTRACT

**Aims** In developing countries such as our country, most of the activities such as carpentry is performed manually and make workers exposure to inappropriate postures, which will increase the prevalence of Musculoskeletal Disorders (MSDs). One way to reduce these disorders is educational ergonomics interventions. The present study aimed at determining the effect of education on reducing ergonomic risk in traditional carpet weavers working in workshops in Golestan province, Iran.

**Materials & Methods** This quasi-experimental study was conducted on 100 employees in 54 traditional workshops in Golestan province of Iran in 2016. The studied population consisted of horsewomen carpet weavers who had at least one-year work experience and were selected based on simple random sampling method. The QEC method was used to assess the risk of musculoskeletal disorders and Nordic standard questionnaire was used to determine the frequency of symptoms of these disorders. The data were analyzed by SPSS 19, using paired sample t-test and Wilcoxon.

**Findings** In the pre-interventional stage, the greatest risk was related to the neck (71.0%) at high-risk level. This intervention was significantly reduced from interventional, and only 5.0% of subjects were at this level ( $p < 0.001$ ). The waist circumference was 97.0% of the subjects before the training at the level of intermediate exposure. After intervention, this amount decreased and most of the subjects (64%) were exposed to low levels of exposure.

**Conclusion** Education can reduce ergonomic risk in traditional carpet weavers working in workshops.

**Keywords** Ergonomics Training; Carpet Weavers; Quick Exposure Check; Inappropriate Posture; Musculoskeletal Disorders

### CITATION LINKS

[1] Major health risk factors in Iranian hand-woven carpet ... [2] Working Conditions in Carpet Weaving Workshops and Musculoskeletal Complaints among Workers in ... [3] Work-related musculoskeletal disorders: the epidemiologic evidence and ... [4] Computer use increases the risk of musculoskeletal disorders among newspaper ... [5] National efforts to identify research issues related to prevention of work-related ... [6] Posture assessment methods in occupational ... [7] Musculoskeletal Problems among Workers of an Iranian ... [8] The prevalence of musculoskeletal disorders causes of disability retirement among Air Force personnel ... [9] Ergonomic intervention effect in reducing musculoskeletal disorders in staff of Shiraz ... [10] Effectiveness of an Ergonomic Education to Modify of Body Posture, Ergonomic Risk Factors and Musculoskeletal Pain Severity in ... [11] Evaluation of the effect of the ergonomic principles' instructions on the dental students' postures; an ... [12] Occupational health (a textbook for primary health care ... [13] Comparison of self-report, video observation and direct measurement methods for upper extremity musculoskeletal disorder ... [14] Application of Ergonomics to Industrially Developing ... [15] Assessment of risk factors for upper extremity musculoskeletal disorders by OCRA index in Meybod ... [16] Occupational Hygiene in Developing Countries: Something to ... [17] Ergonomic assessment of musculoskeletal disorders risk level among workers of a petrochemical ... [18] Musculoskeletal Symptoms Assessment among ... [19] Musculoskeletal symptoms as related to ergonomic factors in Iranian hand-woven carpet industry and general ... [20] Musculoskeletal problems in Iranian hand-woven carpet industry: Guidelines for ... [21] Prevalence of low back pain among handloom weavers in West ... [22] Evaluation of the frequency of musculoskeletal disorders and ... [23] Prevalence of Musculoskeletal Disorders among Hamadan ... [24] Risk assessment of musculoskeletal disorders by QEC method in ... [25] Evaluation of the influence of ergonomic ... [26] The impact of ergonomics intervention ... [27] A randomized controlled trial to prevent patient lift

## Introduction

Carpet weaving industry is one of the oldest handicrafts in Iran. Nowadays, carpet is one of the most important and most valuable items in the country and still in most Iranian villages, weaving carpets is done manually in traditional and non-standard workshops by one or a few people, using a very simple and old tool<sup>[1]</sup>.

Working in this industry is accompanied by musculoskeletal disorders, such as spinal deformities, fingers, and legs or other areas of the body<sup>[2]</sup>. These disorders affect the muscles, tendons, ligaments, joints, peripheral nerves, and blood vessels and cause clinical symptoms such as tendon inflammation and related conditions (tenosynovitis, epicondylitis, and bursitis), compression of the nerve (carpal tunnel syndrome and sciatica), and osteoarthritis<sup>[3-5]</sup>. Various factors play a role in the occurrence of these disorders, including unstable posture, force exertion, repetitive work, and long-term constant work<sup>[6,7]</sup>.

Musculoskeletal disorders as well as other occupational diseases can be prevented<sup>[8]</sup>. Correcting the potential exposure of ergonomics to prevent musculoskeletal disorders is very important. Ergonomic exposure along with poor ergonomic conditions is reduced by controlling strategies such as changing work practices and policies, shortening the length of work shift, increasing rest time, and appropriate training for the worker<sup>[9]</sup>.

In a study conducted by Murshid *et al.*, ergonomic training was effective in improving the physical condition of individuals<sup>[10]</sup>. However, in the Jacobian's study, ergonomic training did not have much effect on the improvement of ergonomic status<sup>[11]</sup>.

The prevention of musculoskeletal disorders and the achievement of optimal performance can be achieved when the equipment, products, working methods, and work stations are designed in accordance with human constraints and capabilities. Power was evaluated by evaluating activities with repetitive motions and providing appropriate working methods to the worker in order to reduce the risk of injury<sup>[12]</sup>.

Today, in many countries, prevention of work-related musculoskeletal disorders has become a necessity and a national priority<sup>[13]</sup>. In Iran, the use of manpower in small industries is vast and widespread<sup>[14]</sup>.

Many studies have been done on musculoskeletal disorders of various workers, especially industrial workers, but, unfortunately, small industries have not received much attention.

Small industries account for 89.2% of Iran's industries, which account for half of the labor force<sup>[15]</sup>. Accordingly, more professional health

programs focus on informal sectors and small workshops<sup>[16]</sup>.

Due to different reasons, such as abundance and low income, low level of training and skills among workers, safety and health are not considered in carpet weaver workshops. The aim of this study was to investigate the effect of education on reducing ergonomic risk in traditional carpet weavers working in workshops.

## Materials and Method

This quasi-experimental study was conducted on 100 employees in 54 traditional workshops in Golestan province in 2016. The studied population consisted of horsewomen carpet wavers who had at least one-year work experience and were selected based on simple random sampling method. Individuals with the history of any system-related musculoskeletal-musculoskeletal events, history of musculoskeletal, and congenital abnormalities were excluded from the study.

The Quick Exposure Check method (QEC) method was used to assess the risk of musculoskeletal disorders and Nordic standard questionnaire was used to determine the frequency of symptoms of these disorders. The stages of the study were as follow:

The QEC method was used to quickly assess the level of exposure of the participants with risk factors for musculoskeletal disorders. In this method presented by Lee and Buckel in 1998, the exposure to 4 areas of the body including the lower back, shoulder/arm, wrist, and neck were evaluated. Also, in this method, according to the observation of the questioner and the worker's reply, comprehensive information on the maximum weight of the displaced parts, the average time of the work, the maximum force applied by one or both hands, and the vibration during work were recorded in the psychiatric tract on the precise view and stressfulness of the job. Based on the QEC method, body organs were classified according to the posture they may have and were given a special code. Finally, based on the overall scores obtained from each posture, the level of corrective actions and ergonomic intervention was determined.

To gain a score of total exposure level, the scores of 4 areas were combined and the maximum possible points were allocated to handover operations (176) and to other occupations (162).

In this method, corrective actions include 4 levels: risk level 1 (less than 40%), risk level 2 (41-50%), risk level 3 (51-70%) and risk level 4 (more than 70%). The third and fourth levels require urgent corrective action<sup>[17]</sup>.

The Nordic questionnaire consists of 2 parts; the first part of the questionnaire contains questions about the demographic data of workers, including

job title, work experience, having musculoskeletal disorders, and individual characteristics such as age, weight, and height. The second part divides the human body's system into 9 regions, including the neck, shoulders and elbows, wrists, waist, hips, thighs, knees, upper parts of the back, and ankles, and a history of progress pain in the above areas is examined. The validity and reliability of this questionnaire were approved as a screening tool. In the study, with a correlation coefficient of 91%, this questionnaire was considered to be persistent [18]. The frequency of musculoskeletal disorders was studied and recorded. The risk of these disorders was evaluated, using the QEC method.

Before the educational intervention, the prevalence of musculoskeletal disorders in the participants was evaluated. The musculoskeletal disorders were evaluated in the last 12 months in the studied participants. In order to evaluate the effect of ergonomic training on carpet weaving in traditional workshops, the subjects were divided into 10 groups of 10 people and trained for 2 months by face-to-face. For continuation and better learning of these principles, each participant was given the pamphlet regarding the ergonomics principals. After 2 months of training, the risk of musculoskeletal disorders was evaluated, using the QEC method.

The data were analyzed by paired sample t-test and Wilcoxon statistical test, using SPSS 19 software.

**Findings**

100 carpet weavers were studied in traditional workshops, all of whom were female (Table 1).

**Table 1)** Demographic variables of carpet weavers who studied

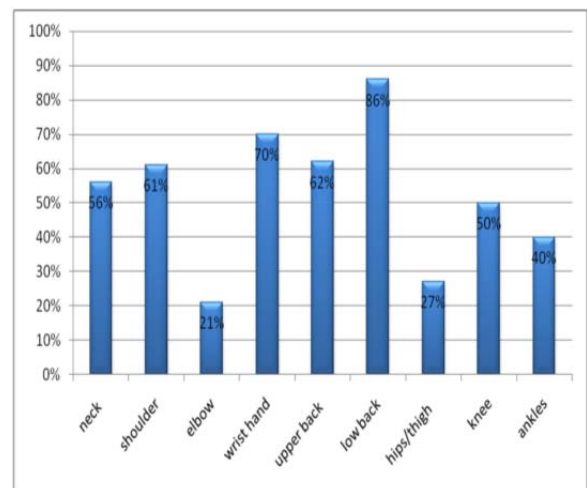
Variables	Mean ± SD	Minimum	Maximum
Age (year)	32.70±12.85	14	68
Work experience (year)	13.96±11.34	1	42
Height (cm)	158.83±13.61	130	180
Weight (kg)	59.44±11.94	38	93

In the last 12 months, the highest percentage of disorder was in the waist and wrists and, the least cases were in elbows and thighs (Diagram 1).

In the pre-interventional stage, the greatest risk was related to the neck, which was the majority of subjects (71.0%) at high-risk level. This intervention was significantly reduced from interventional, and only 5.0% of subjects were at

this level (p<0.001). The waist circumference was 97.0% of the subjects before the training at the level of intermediate exposure. After intervention, this amount decreased and most of the subjects (64%) were exposed to low levels of exposure (Table 2).

In the pre-intervention phase, most of the subjects (94.0%) were at risk level 3, who needed corrective actions in the near future, which dropped to 33.0% after the intervention. Overall evaluation of ergonomic risk before and after training showed a significant difference (p<0.001; Table 3).



**Diagram 1)** Musculoskeletal disorders in carpet weavers in the last 12 months

**Table 2)** Ergonomic evaluation of different body areas before and after intervention in carpet weavers (n=100)

Levels	Pre-training	Post-training
<b>Waist</b>		
Down	3 (3.0%)	64 (64.0%)
Medium	97 (97.0%)	36 (36.0%)
Top	0	0
Very high	0	0
<b>Shoulder/arm</b>		
Down	3 (3.0%)	28 (28.0%)
Medium	97 (97.0%)	72 (72.0%)
Top	0	0
Very high	0	0
<b>Wrist/hand</b>		
Down	2 (2.0%)	21 (21.0%)
Medium	73 (73.0%)	79 (79.0%)
Top	25 (25.0%)	0
Very high	0	0
<b>Neck</b>		
Down	0	4 (4.0%)
Medium	3 (3.0%)	22 (22.0%)
Top	26 (26.0%)	69 (69.0%)
Very high	71 (71.0%)	5 (5.0%)

In all of items p<0.001

**Table 3)** Results of overall evaluation and effects of intervention on carpet weaver work posture

Risk level (QEC)	Before Intervention (%)	After Intervention (%)	p-value
Level 1 (less than 40%)	1.0	26.0	<0.001
Level 2 (41%-50%)	5.0	41.0	
Level 3 (51%-70%)	94.0	33.0	
Level 4 (More than 70%)	0	0	

## Discussion

In today's modern world, traditional work of knitting is very valuable in ancient culture, and it is imperative that the occupants of this profession, like other industrial workers, be adequately cared for and covered by occupational health services, because this profession can provide livelihoods for a large part of the rural community of the country. This study, based on the questionnaire, showed that muscle skeletal symptoms are common among carpet weavers. Most carpet weavers in the last 12 months experienced musculoskeletal symptoms in all 9 areas of the body and the highest disturbance was 86% in relation to the area/rest.

Compared to the National Health Survey of Iran, the difference in the prevalence of musculoskeletal disorders is significant [19]. Therefore, the ergonomic intervention program can be of great importance. Musculoskeletal disorders in different parts of the traditional weavers were high in shoulders, lower back, wrists, neck and knees [19, 20].

A study conducted by Durlov *et al.* found that carpet weavers suffered from musculoskeletal disorders, and the highest complaint was in the lower back region, which could be due to long-term sedation in a limited and static manner [21].

In this study, a statistically significant relationship was found between age and prevalence of musculoskeletal disorders in elbow, thigh and knee areas. In some previous studies, a relationship between age and musculoskeletal disorders have been reported [22, 23].

Furthermore, the weight with ergonomic risk of knee and ankle and history of work with ergonomic risk of hip and knee regions was statistically significant. This finding is consistent with the Ahmadi *et al.*'s study, which found this relationship in dental practitioners in Hamadan [23]. Age, work experience, and body weight are important variables that increase each musculoskeletal disorder in different areas of the body by increasing each of them alone in the long run.

Among the ergonomic postures of different parts of the body during work, the greatest risk is for the neck region, of which most of the subjects (71.0%) were at high risk. This could be due to the long stagnation of the neck region. This finding is consistent with Choobineh *et al.*'s research findings in the carpet industry, in which 84.9% of the subjects had incorrect postures [7].

The level of lumbar exposure for most carpets is moderate, which is due to the fact that most of them used horizontal carpets where the weaver was forced to sit on a squat in front of a carpet and work for long time. This action will cause the waist disorder. The reason for using more horizontals is the easy and economical installation of horizontal

carpets rather than the vertical. Considering that most of them use a carpet map, for the sake of a better view, the roles of the carpets, which are small and require a high visual requirement, force the person to bend towards the area towards map and texture. This causes the carpet weaver to be placed in undesirable posture.

Risk assessment by QEC showed that 94% of carpets had a high risk level before intervention, indicating that the conditions and work environment were damaging in this occupation. This finding is consistent with the findings of the study carried out by Mehpervar *et al.* in the food industry, concluding that most people are at a high risk level [24].

The prevalence of disturbances in various areas of the body is higher for those who are non-neutral during work [19]. The lack of proper fitting equipment in carpet workshops can be a major cause of the unpleasant limitations and situations that make people in bad physical condition. After the educational intervention, most carpets wavers were at moderate level. The difference between the level of risk before and after intervention was achieved for the study group ( $p < 0.05$ ). Therefore, the effect of training cannot reduce the risk of ergonomics and the reduction of musculoskeletal disorders was ignored.

Based on previous studies, ergonomic intervention and appropriate training can be considered as one of the appropriate tools for reducing musculoskeletal disorders [25]. However, some researchers claim that intervention alone cannot be an effective way to reduce the incidence of musculoskeletal disorders in many work environments [26, 27]. Since education can be effective in modifying the physical condition, it has no effect on the physical environment and the ability to use the tool [27]. Perhaps this is because of the inappropriate use of the teaching method, but the result of the educational intervention according to the method of training can be different.

One of the limitations of this study was the limitation of financial resources, which unfortunately did not have the potential for ergonomic intervention in the design of the environment, tools, and equipment at the same time as educational intervention. The next limitation was that carpet workshops were expanded in different cities across the province, which made little difficulty for the research process.

However, it is suggested that various ergonomic interactions such as workplace, tools and equipment modification, and continuing education courses be applied for future studies.

Considering the results and the effectiveness of teaching ergonomic principles on the reduction of

musculoskeletal disorders, it is suggested that the responsible authorities work with ergonomic training to correct the postures of carpet weavers and increase the awareness of carpet weavers so that this health problem among working sites cannot be removed.

## Conclusion

Education can reduce ergonomic risk in traditional carpet weavers working in workshops.

**Acknowledgements:** The authors would like to thank the female carpet weavers, who cooperated in the implementation of the research.

**Ethical Permissions:** All procedures were performed in accordance with the Student Research Committee of Gonabad University of Medical Sciences.

**Conflict of Interests:** The authors declare that there are no conflicts of interests regarding the publication of this article.

**Authors' Contribution:** Gholami A. (First author), Introduction author/ Methodologist (30%); Teimori Boghsani Gh.H. (Second author), Assistant/ Statistical analyst (25%); Fouladi Dehaghi B. (Third author), Discussion author (20%); Tamaddon Yolmeh J. (Fourth author), Original researcher (25%).

**Funding/Support:** None declared by the authors.

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