Original Article

Prevalence of Musculoskeletal Disorders and Analysis of Working Postures by OWAS among Saffron Harvesters

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Abstract

Background and Purpose: Work-Related Musculoskeletal Disorders (WRMSDs) annually dismiss numerous afflicted workers to medical centers and also cause inefficiency among the workers. Given that Iran is one of the major saffron producers and exporters, and having many workers involved, the present study was conducted with the aim to determine the prevalence of musculoskeletal disorders and to analyze the postural conditions of saffron harvesters.

Materials and Methods: In this cross-sectional study, 110 saffron-harvesters were randomly selected. The prevalence of WRMSDs was examined through the Nordic Questionnaire (The data were analyzed using SPSS Software, Version 21), and corrective measurements were determined for these postures through the OWAS postural analysis.

***Results*:** The results showed that the most compromised regions of any prevalent disorders were back (38%) and waist (31.6%). In the postural analysis, trunk (80%) and legs (13%) were among the corrective measurements of category II, and arms were at category I. In the analysis of combined postures, it was found that 46% of them were at corrective measurements of category II, and 31% were at category III.

***Conclusion*:** Regarding the Nordic Questionnaire's results and its comparison with the OWAS postural analysis, it was concluded that it was of utmost importance to take corrective measurements to prevent the mentioned damages. Therefore, main ergonomic recommendations and a product-oriented design guideline were advised to correct the postures.

***Keywords*:** OWAS; Posture analysis; Saffron Harvester; Occupational Health; Musculoskeletal Disorders

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1. Introduction

One of the critical issues of work-related injuries and disabilities throughout the industrial countries is caused by musculoskeletal disorders (MSDS) (1), which is considered to be one of the major factors relating to the employees' and workers' disorders. It counts for 7% of the total malfunctions and 19% of hospitalizations (2) in a way that 62% of the patients have mobility limitations (3). These disorders are caused by a sudden and repetitive trauma to the musculoskeletal system that could occur in the spine, upper and lower limbs (leading to tension), inflammation, degeneration, rupture, nerve or arteries entrapments, and bone fractures. These disorders have symptoms, such as discomfort, pain, fatigue, stiffness, sensory disorders, limited range of motion, and loss of control. If the working environment and occupational duties cause and intensify any of these afflictions, it is known to be work-related musculoskeletal disorders (WRMSDS) (4). Musculoskeletal disorders refer to any tissue damage of the nerve system which leads to the malfunction of associated organs (5). Its outcomes affect the individual's performance, and its prevalence leads to low quality of work, high healthcare costs, wasted work time, and individual's fatigue (6).

An array of research has been conducted to improve the quality of worker's posture in a range of industries; however, this is not the case for only Iranian saffron workers. Iran is one of the major producers and exporters of Saffron (75-80% exports and a 50-million-dollar exchange resource) (7). Having 41,325 acres under cultivation and an annual production of 150 to 170-ton saffron, Iran is the largest producer of saffron in terms of quality and quantity throughout the world. Such numbers require a huge body of human resources. According to IRNA (Islamic Republic News Agency), about 400,000 workers are daily involved in cultivating and harvesting saffron only in the Torbate Heidarieh town (8), where around 200 kgs of this product is harvested. Regarding the lack of mechanized cultivation systems, it is of utmost necessity to examine musculoskeletal disorders in the working process and to propose effective solutions to eliminate them. Based on some interviews conducted by authors of the present paper, a high percentage of workers express having numerous physical difficulties whilst working. The employers stated that their workers usually requested breaks due to severe back pain and bad working conditions.

Figure 1. Phases and working postures of saffron harvesters

2. Material and Method

This cross-sectional study was conducted in 2 steps which were complementary in achieving the optimized result. In the first stage, the Nordic Questionnaire was used to examine the workers' musculoskeletal disorder and to select an appropriate method to analyze it. The descriptive study was proposed in Razavi-Khorasan Province and regarding the parameters, such as the employment >4 days per week, and also having work history >6 months (400,000 workers are involved in this sector), as well as considering the remarkable precedent studies, 110 active saffron harvesters were chosen randomly and replied to the questionnaire through the detailed explanation of variables by the surveyor. According to this questionnaire designed by Scandinavian Industrial Hygiene Institute, musculoskeletal system is divided into 9 regions (as neck, shoulders, elbows, wrists/hands, upper back, low back, knees, and ankles/feet), and also variables, such as the type of occupation, work experience, history of musculoskeletal disorders during the previous year were included and evaluated (9). Final optimizations were also made by the researchers using the information provided by the respondents. After gathering and grouping the data, they were entered into computer and were statistically analyzed through SPSS Software (Version 21).

To verify the results of the questionnaire, descriptive statistics, "chi-squared test – relationship evaluation" was used. Significant and meaningful levels of statistical tests ($p<0.05$) were adopted. In the second step, the OWAS Method was used for analyzing postures. Thus, photos were taken from the occupation for about 45 minutes with 30-second intervals. A total of 90 images were evaluated. By analyzing the results, the levels of corrective measurements were determined and analyzed using the previous results provided by the questionnaire. (This method is based on the systematic classification of working postures which are accompanied with careful observation of working tasks). In this method four codes are determined according to the body postures and movements. These codes show the level of musculoskeletal risk and the priority of ergonomic interventions and modifications. By using OWAS Method and comparing it with Nordic Questionnaire, the category of corrective measurements could be determined in various body parts, and recommendations could be provided to prevent pains in these regions. Based on previous research, the procedure of this research was approved by ergonomists and relevant experts.

3. Results

A total of 110 subjects participated in this study (44% men and 56% women). Demographic variables were also recorded to identify the different groups (Table 1). Then, the Nordic Questionnaire was presented. The results showed that during the last 12 months, the participants had experienced musculoskeletal disorders. Having the highest prevalence in the back (38%) and waist (31.6%) with the least being in the thigh (5%) (Table 2).

Table 1. Demographic data according to gender and relationship with MSDs (N=110)

	Gender		
Demographic indicators	Male average±deviation	Female average±deviation	P Value
Age (year)	28±11.3	34±13.6	0.68
Weight (kg)	74±12.2	65±8.7	0.152
Height (cm)	174.7±6.6	162.3±5.4	0.75
Work experience (year)	4.1±3.8	5.7±4.9	-
Numbers	53 (48.18%)	57(52.81%)	-

* P value less than 0.05 is significant

Table 2. Frequency of musculoskeletal disorders prevalence during the last year based on Nordic Questionnaire and its relationship with work experience (n=110)

Member	**Neck**	**shoulder elbow**	**Hand & wrist back**	**waist Thigh & buttocks**	**Knee**	**ankle**
Number	29	20 8	15 42	35 5	16	12
Prevalence degree of MSDS	26 %	18% 7.2%	13.5% 38%	31.8% 5%	14.5%	10.9%
P Value	*0.006	*0.013 *0.038	0.28 *0.004	*0.003 0.10	*0.013	*0.046

* P value less than 0.05 is significant

By investigating the relationships between the variables, it was documented that there was no significant correlation between "the prevalence of pain and musculoskeletal disorders" and the workers' "age" (p=0.68), "height" (p=0.75), and "weight" (p=0.152). But there was found a significant correlation between the "musculoskeletal disorders of the neck, shoulder, elbow, back, waist, knee, and ankle" and "the work experience" ($p<0.05$). On the contrary, no significant correlation was observed between the "prevalence of pain in the wrist and hand regions (p=0.28), hip (p=0.10)" and "work experience". In the OWAS postural analysis, the classification results of corrective measurement categories in different regions of the body were provided, and the cumulative frequency was also reported in percentage (Table 3).

Table 3. The disorders' cumulative frequency related to any organ and the corrective measurements based on OWAS Method (N=110)

	Posture	Number	Percentage of cumulative frequency	Action Categories
Back	Straight	13	12%	1
	Bent forward/backward	69	63%	2
	Twisted or side bent	9	8%	1
	Bent and twisted	19	17%	2
Arms	Both below shoulder	98	89%	1
	One at/or above shoulder	9	8%	1
	Both at/or above shoulder	3	2.7%	1
Legs	Sitting	73	66%	1
	Standing with both straight	5	4%	1
	Standing with a weight on one straight leg	1	1%	1
	Both knees bent	14	13%	2
	One knee bent	1	1%	1
	Kneeling	2	2%	1
	Walking	14	13%	1

Whilst photographing the harvesters, seven different postures were recorded. Then, their measuring categories were determined. It was demonstrated that 23% of the activities were placed in category 1 (it did not require any modification), 46% in category 2 (corrective action was necessary for the approaching future), and 31% in category 3, which was stressful body posture (the necessary correction was required as soon as possible), and it was considered to be a very problematic posture (Table 4).

Table 4. The level of cumulative frequency and the percentage of combined postures and corrective measurements related to any of them

*Posture code	No. of Postures	Percentage	Action Level
3111,3161,1171	3	23	1
2111,2161	2	46	2
3141,2141	2	31	3
-	0	-	4

* Each of these four-digit codes represents a unique posture. According to the OWAS procedure, the digits—from left to right—indicate the posture of Back, Arms, Legs and Force, respectively.

4.Discussion

Regarding the results, it was evident that the highest prevalence of pain was in back (38%), then in waist (31.6%), neck (26.8%), shoulder (18%), knee (14%), hand (13.5%), ankle (10.6%), elbow (7.2%), thighs and hip (5%), respectively. Since the workers' posture was in the bent condition (Bent forward/backward (%63), and (bent and twisted, (%17)), it was expected that pain to be highly reported in the two regions of back and waist as the precedent research showed among farmers, but the highest frequency of pain was recorded to be in the waist, knee, and waist, respectively, while low back pain and knee problems had the highest frequency among them. These issues were caused as a result of standing or

sitting for a long period of time, displacement and manual material handling, and undesirable workstations (10). The results of the current study showed that the prevalence of WMSDs was relatively high among participants, and most of them were complaining at least about the painfulness regions in their body. This finding was similar to the precedent research among auto mechanic (11).

By considering the results of two parts that are aligned and by comparing them with together, the result of each part was approved. Likewise, in a study on bakery jobs, Ghamari and colleagues also reported waist pain in high percentage (55.8%) (12), which was in line with the results of current study. Jabari et al. used the Nordic questionnaire and found waist (55%) to be the most common organ involved in MSDs (13). Also, in a case study on the prevalence of musculoskeletal disorders among mine workers, Hasanzadeh found skeletal disorders in the neck (14.5%), waist (38.2%), and back (18.2%) (12/3). By comparing the present study with the previous posture studies among dentists, it can also be claimed that the repetition of an action through inadequate postures is a factor contributing to pain developments in back and lower back (14). As demonstrated in a Meta-analysis research, the WMSDs in lower limb, and especially in back and knee are more prevalent in Iran compared to similar studies in other countries (1).

In the next step in this research, which was investigating the category of corrective measurements through the OWAS method, it was demonstrated that lower back was one of the regions where 80% of postures were located in category II of corrective measurements (twisted or side bent). It was sub-categorized by 63% related to spine curvature, 17% related to curved and rotated lower backs, and finally other 20% related to body regions. By comparing it to the results of research on musculoskeletal disorders during the last 12 months (which showed high level of pain in back and lower back), it was expected not to see a normal posture in these regions, consequently, requiring corrective measurements. In a study on posture examination of welders, Soltani and colleagues found that category II of corrective measurements in back were 66% (15). Regarding the similarity between the posture of welders and saffron-harvesting workers, it can be deduced that the findings and results were already confirmed. Concerning the Nordic Questionnaire results, the prevalence of pain and disorders was rare, as well.

On the region of leg, 13% of postures were in problematic position; the remaining 87% was in the category I of the corrective measurements, the highest percentage of which (66%) was attributed to the sitting posture. By comparing the results of Nordic questionnaires and OWAS method, it can also be inferred that the prevalence of musculoskeletal disorders and the level of corrective actions were aligned. Also, by increasing the prevalence of pain in different parts of the body, the level of corrective measures were changed, as well.

In the results of combined postures, seven codes were presented as body postures while working, and the findings showed that 23%, 46%, and 31% were in categories I, II, and III of the corrective measurements, respectively. Through comparing the Nordic questionnaire results with the combined posture analysis, it was also shown that by increasing in percentages of pain prevalence, the corrective measure levels were also enhanced at the same part of the body. In combined posture analysis results, codes with action level II (2111,

2161) and III (3141, 2141) had codes of 2 and 3 for back, separately, for which, in Nordic Questionnaire, the percentages of back and waist were closely 38% and 31%, respectively. It was just like similar position in packaging workers of factories, which showed the highest WRMSDs related to back (24.6%) (16).

Although a few corrective measurements of category IV (urgent corrective measurements) have been detected, but in case, the current trend continues regarding the musculoskeletal disorders, the significant correlation between the pain in various parts of body and work experience will be estimated. Eventually, due to a high percentage of corrective measurements in categories II and III, it is expected that this trend will continue to develop, and not only the percentage of cumulative frequency in combined postures will grow higher, but also some cases of category IV will appear.

5.Conclusions

In order to prevent the exacerbation of pain in various regions of the body and to take actions to correct the postures whilst doing activities, the ergonomic interventional programs seem to be necessary. It is recommended to investigate this job by employing Man-Machine System (MMS), an analytical model in Ergonomics, in which the system is divided into four fundamental elements – Person, Equipment, Environment, and Task. These elements become subject to in-depth analysis. (17).

According to MMS definition and also other provided information in this field, we can deduce that two factors of MMS in the process of Saffron harvest work should be considered and need to be solved; worker's position as a Man/Human posture and Equipment which are tightly related to each other. To address such problems, the following corrective measures and benefits of a Product Design-Oriented approach have been suggested. All provided information is based on experts' points of view including physiotherapists, occupational therapists along with Industrial and Medical Designers (Table 5).

Table 5. Corrective measures

	physiotherapists and occupational therapists' advice and recommendations
1	Regular visiting by medicine team
2	Avoiding overload, over use and over work
3	Obeying the related job rules
4	Using auxiliary equipment
5	Taking median rest
6	Training for work related skill
7	Preventing injures
8	Considering physical fitness
	Industrial Designers' recommendation to design an assistant-product
1	Using the back rest to rest frequently
2	Applying a basket to reduce excessive movements for the arms
3	Using the adjustable prop to reduce pressure on the upper limb during working time
4	Product considering the user's leg in an obtuse angle
5	Using the adjustable back rest and protector
6	Using suitable materials in order to prevent fatigue and increase comfort

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