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Musculoskeletal Disorders Evaluation of Glass Factory Workers using the Discomfort Survey Questionnaire and Assessment Repetitive Tasks (ART) Method

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ABSTRACT

Aim: MusculoSkeletal Disorders (MSDs) are the most common and most costly occupational injuries and one of the main causes of work-related disability and disability among workers. The aim of this study was musculoskeletal disorders evaluation of glass factory workers using the discomfort survey questionnaire and Assessment Repetitive Tasks (ART) method
Method and Instruments: This study was a cross-sectional study. Data were collected by census of active workers in the two main production halls. The MSDs data among 40 workers were collected using the discomfort survey questionnaire. Four types of activity were evaluated by ART method. The study data were analyzed using SPSS 22 software.
Findings: The results obtained from the questionnaire and evaluation of ART method were consistent. According to the results obtained from the left and right were as different levels of risk and the right to 42.17% of the average risk level, 28.14 percent and 28.14 percent of high-risk but low level of risk to low risk level and 85.42% of the left 85.42 percent average risk and 28.14% of the high - risk level is obtained.
Conclusion: For most tasks sides of the body with moderate risk level. By providing simple and low-cost solutions, as well as management of these disorders can be prevented to some extent.

Keywords: MusculoSkeletal Disorders, Discomfort Survey, Assessment Repetitive Tasks (ART).

Introduction

MusculoSkeletal disorders (MSDs) are one of the most common and costly occupational injuries and considered as one of the most important causes of work-related disabilities and disability in workers. MSDs include disorders of the muscles, tendons, tendon sheaths, peripheral nerves, joints, bones, ligaments, and blood vessels and are caused by repetitive stress over time or an immediate or acute trauma such as slipping and falling. When work environment and performing certain work tasks contribute to the development of this complication ,these disorders are considered work-related. However ,MSDs are generally multifactorial disorders [1-2].
Today ,the growing trend of technology in developing countries ,despite improving the work quality ,causes harmful factors that threaten the health of the workforce. In the glass manufacturing industry ,glass containers for foods are produced .The type of manufacturing process in this industry is such that it creates an inappropriate posture, repetition of movement ,and so on .Active workers in this industry are exposed to a lot of ergonomic problems ,including musculoskeletal disorders in the lower back ,neck ,and so forth. Poor ergonomic conditions reduce labor productivity and increase industry costs due to compensating the workers for the development of MSDs. Therefore ,the worker ergonomic needs to be addressed. Ergonomic studies in the glass manufacturing industry are

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limited and one of the methods that have been used is the RULA, which is a quick method to evaluate the upper extremities and confirm the existence of MSDs in this industry [2-3].

The ART (Assessment of Repetitive Tasks) is a method for ergonomic assessment, which is introduced by the Health Seafety Environment (HSE) organization in 2007. The method is used to assess the effects of repetitive tasks, such as assembly, packaging, etc., on upper extremities, especially hands and arms. In addition to consideration of all risk factors and offering a final score for a task, the other strength of the ART method is that it also provides a separate assessment for each risk factor, a risk level that is defined by three colors of green, yellow, and red for each score [4-5]. All aspects considered in assessment methods of upper extremities, such as Quick Exposure Check (QEC), rapid Upper Limb Assessment (RULA) , and SI Strain Index), are also included in the ART method but ART method is presented as an easy and practical method [6-7].

ART method is used in cases such as screening of repetitive tasks with upper extremities, increasing workers' understanding and awareness about the dangers of repetitive tasks, and recommendation of contexts for work enhancement, and so on. Several studies have been conducted using the ART method in occupations such as assembly lines, tile and mosaic manufacturing, and hospitals [8-10]. The aim of this study was musculoskeletal disorders evaluation of glass factory workers using the discomfort survey questionnaire and Assessment Repetitive Tasks (ART) method

Methods and Instruments

This study was a cross-sectional study. Data were collected by census of active workers in the two main productionb halls. The MSDs data among 40 workers were collected using the discomfort survey questionnaire. Four types of activity were evaluated by ART method. Workers participating in the study filled out a consent form. Workers who were reluctant to cooperate and whose upper limbs were not involved were excluded from the study. The study data were analyzed using SPSS 22 software.

The types of data in this study were descriptive and inferential statistics. The descriptive statistical data, such as the frequency of MSDs, were analyzed based on the organ involved and based on workstations and according to prevalence and frequencies. Inferential statistical data such as the relationship between disorders and type of activity were analyzed using the chi-square test.

After determining the type of workers' musculoskeletal discomfort in different stations, those stations where workers feel pain and discomfort in their upper extremities were specified and then assessments were done using the ART method and by preparing photos and videos from the posture of people working in those stations. Thus, for each similar task, photos and videos were prepared from 2 different people working in 2 different stations, except for the equipment repair section where only one person was examined. In other words, since there are 4 production lines in each saloon and subsequently 4 control rooms that have the same functions and workstation, the assessment was done and photos and videos were taken from only 2 control rooms, and then the ergonomic risk factors in this factory were determined.

The results of the ART ergonomic assessment were compared with the data from the survey, and after reviewing the appropriate and standard solutions available, applicable corrective recommendations for reducing MSDs were proposed [7-10].

Findings

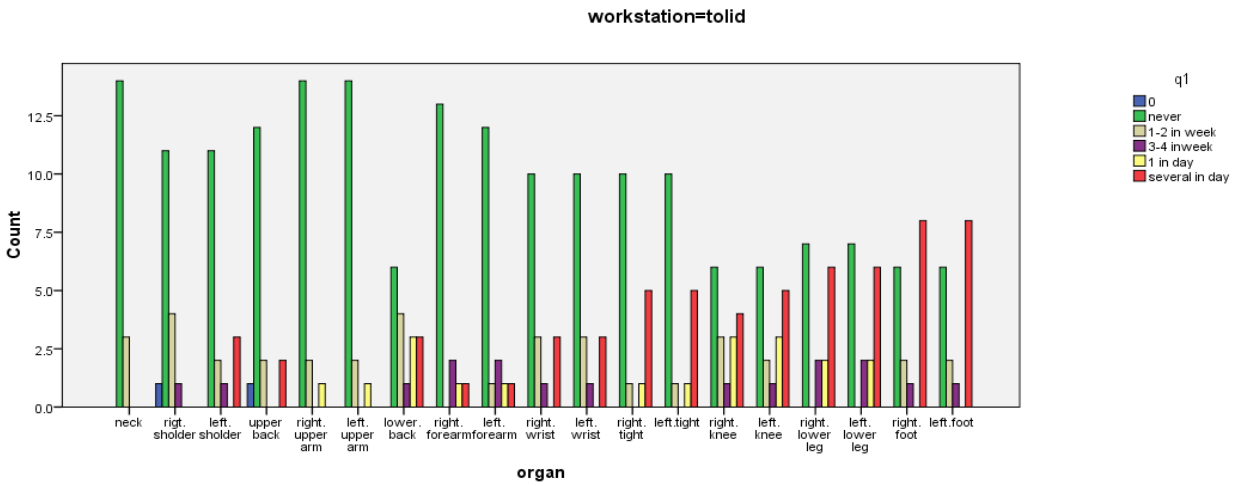
In this factory, 70 people were working in 2 production halls in two shifts. Forty workers who wished to cooperate, participated in the study. All the workers were men. The average age of the workers was 37.6 years. The average work experience of the workers was 14.5.5 years. 90% of their education was diploma and postgraduate. Data were analyzed using spss 22 software. The feeling of pain and discomfort over the past week separated by 19 organs and in the form of 5 options (never, 1-2 times a week, 3-4 times a week, once a day, several times a day) were examined. The results in two production and control sections are presented below as two separate graphs. As shown in Figure 1, in the produce section, pain and discomfort are more prevalent in the shoulders, back, lower extremities such as the knees and legs. Figure 2 shows that in the control section, pain and discomfort are seen more in all upper and lower extremities, especially the neck and lower back.

The ART method is also used in this study to assess the posture of workers. The sections under study were divided into two sections of production hall and repair, and tasks under assessment included lubrication of casting molds, quality control of glasses, equipment repair, and polishing of casting molds, where upper extremities were involved and had repetitive movement. Seven workers were evaluated and in each section, except the repair section, 2 workers with similar tasks were evaluated and compared.

The results of the evaluations showed that people with similar tasks have scores close to each other with slight differences and their risk levels were equal. Table 1 shows the scores and risk levels of participants separated from the left and right sides of the body. In the repair section, the scores obtained for each of the tasks were the same on both sides of the body. However, in the production hall, the scores of both sides were not equal and the score for the right side was greater than the left side of the body, except for the section of casting mold lubrication, where one of the two participants had a great score in the left side and the other had a great score in the right side. The highest

Table 1) The risk level scores in the studied tasks and in different stations

Low risk (0-11)		Moderate risk (12-21)			High risk (22 and higher)	
Workstations	**Task**	**Most important risk factors**	**Right side score**	**Right side risk level**	**Left side score**	**Left side risk level**
Production hall	Lubrication of casting molds	Lower back and wrist	19	Moderate	7	Low
			7	Low	19	Moderate
	Quality control of glasses (mirror watch)	Neck posture	17	Moderate	7	Low
			17	Moderate	7	Low
Repair section	Polishing molds	Neck posture, lower back, and wrist	18.75	Moderate	20.75	Moderate
			18	Moderate	19	Moderate
	Repair	Neck posture, lower back, and wrist	24	High	24	high



Graph 1) The production section, the level of pain and discomfort in different organs

score obtained for the repair section is 24, which has a risk level of 24.

The risk levels obtained from the left and right sides are presented as percentages in Table 2. According to the results, for the right side of the body, the moderate risk level obtained as 71.42% and the low- and high-risk levels obtained as 14.28%. However, for the left side, the low and moderate risk levels obtained as 42.85% and high risks level obtained as 14.28%. In general, it can be concluded that for most of the tasks, the two sides of the body have a medium risk level. On the left side, the risk levels of the right and left sides were the same. It can be said that in these tasks, the right side of the body is more at risk. The results of Chi-square statistical test showed that there is a relationship between the two variables of type of activity and type of disorder (P-value = 0.05).

Intervention strategies

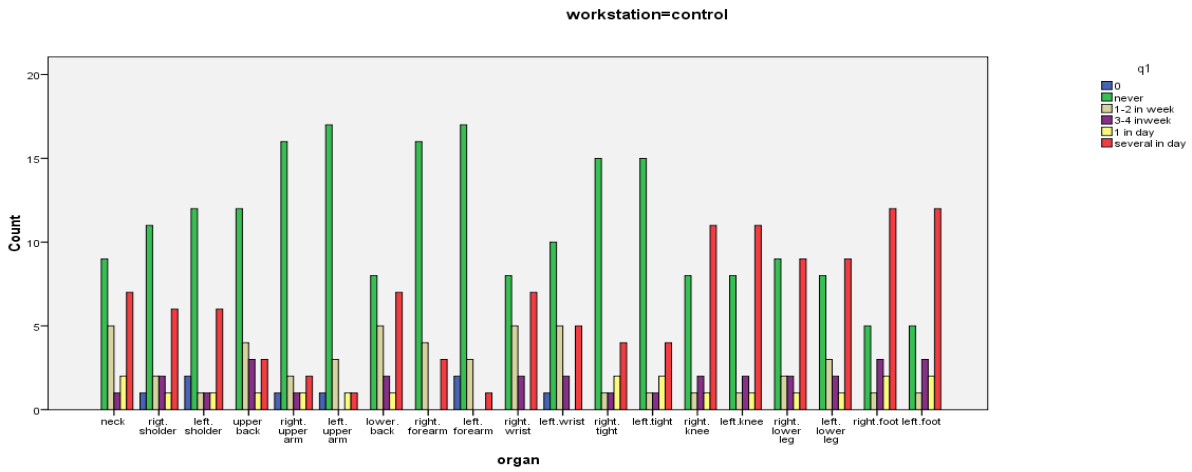
Several strategies have been suggested to improve workstations and correct the posture of workers. In the repair section that has the highest risk level, the equipment should be held suspended by a crane to increase the height of the lower back, which corrects the posture of the lower back and, to a certain extent, the posture of the neck. In other sections, management measures including rotation of the work shifts and performing exercises to reduce static posture are suggested. In the section of casting mold lubrication, since the task is done in 5-minute intervals, after finishing each task, the worker reduces the work risk level to some extent by sitting on the seats embedded in the workplace.

Table 2) The risk levels obtained for the right and left sides of the body

Risk level Side of the body	Low (0-11)	Moderate (12-21) N(%)	High (>22)
Right side	14.28%	71.42%	14.28%
Left side	42.85%	42.85%	14.28%

Discussion

In this study, the prevalence of discomfort and disorders among 40 workers was collected using the discomfort survey questionnaire. Franzbla et al. (1997), by using the discomfort survey, conducted a study in the US and of 148 workers and assembly workers in the automobile spark plug production factory in order to determine the relationship between the ergonomics of workstations and MSDs in the upper extremities. It was reported that the results obtained from this survey are reliable and practical for epidemiological studies [11]. The results showed that the



Graph 2) The control section, the level of pain and discomfort in different parts of the body

highest incidences are in the lower back and the neck. There is a correlation between the results of the assessment method and the data from the discomfort survey.

In the produce section, the feeling of pain and discomfort were more common in the shoulders, lower back, and lower limbs, such as the knees, while in the control section, the feeling of pain and discomfort were more common in the upper extremities, especially the neck. In a study by Azizi (2012), in the glass manufacturing industry, the prevalence of disorders in the control section was reported to be more than that of the other sections, which is in line with the results of our study [3]. The highest prevalence of MSDs in the last 12 months in a study of marquetry workers in Kerman, in which 26 Nordic questionnaires were first completed, was in the neck (66.7%) and the upper back (63.2%). In this study, the results also indicated a correlation between the data on the Nordic questionnaire and the ART assessment method [9]. In a study conducted by Mortazavi et al. (2012) on the role of posture in the development of disorders in a TV manufacturing factory using the Nordic questionnaire and the RULA method, the frequency of pain in different parts of the body obtained as 28% in the neck, 38% in the shoulders, 2% in the elbows, 32% in the wrists, 23% in the back, 38% in the lower back, 20% in the knees, and 20% in the legs [12].

To the task of quality control, the most important risk factor is related to the neck posture due to the static posture of the neck during the process of quality control of glasses and for the task of casting molds lubrication, the most important risk factor is related to the posture of lower back due to working at a stand up position and the angled posture of the lower back during lubrication.

In the equipment repair section, the most important risk factors were the posture of the neck, lower back, and wrists. In this task, due to the positioning of the equipment during the repairs, the worker is forced to bend his/her neck and lower back and twist his/her wrist. The task of casting mold lubrication has the highest risk level, which is due to the postures of the head, lower back and wrist, and flat surface of workbenches, as well as the way the machine is designed and its incorrect grip. In a study by Abbaszadeh et al. (2013) conducted in the electrical assembly industry using the ART method, the most important factors were hand grip and breaks during a work shift [7].

The scores obtained for the right and left sides of the body were different, but had the

same risk level. The scores obtained for the right side of the body were also higher, except for the polishing of molds and equipment repair, in which the scores for two sides of the body were equal. In the section of casting mold lubrication, where two workers were studied, one had a higher score in the left side and the other one had a higher score in the right side, which is due to the fact that one of the workers is left-handed and the other one is right-handed, and the side that is involved in the job has the higher score. In a study by Roodbandi et al. (2013) on marquetry workers in Kerman using the ART method, the calculated risk score for the right hand in all tasks was higher than the left hand, which is consistent with our results [9].

According to the results, the risk level obtained from the left and right sides was different. For the right side, the moderate risk levels obtained as 71.42 percent, the low-risk levels as 14.28 percent, and the high-risk levels as 14.28 percent, however, for the left side, the low-risk levels obtained as 42.85 percent, the moderate risk levels as 42.85 percent, and the high-risk levels as 14.28 percent. In general, it can be concluded that for most tasks the two sides of the body have moderate risk levels. In a study by Motamedzadeh et al. Conducted on assembly workers in a manufacturing factory, the results before intervention showed that 21.7 percent were at a low-risk level, 48.3 percent at a moderate-risk level, and 30 percent at a high-risk level [8]. In the study by Azizi et al. (2012) conducted in a glass manufacturing factory using the RULA method, the workstations had high-risk levels and required urgent actions for ergonomic intervention, and some other stations had low-risk levels [3]. In the study by Abbaszadeh, the risk level of the assembly workers for all tasks was high. The 55 percent of tasks were at a low-risk level, 55 percent were at a moderate risk level, and 35 percent were at a high-risk level [7]. The risk levels obtained in the study on the repetitive tasks in the tile industry included low and medium risk levels for both the right and left sides of the body. The results obtained in this study indicated that in most work conditions, the risk levels were low for upper extremities in repetitive tasks in the tile industry [13]. In a study by Monsey McLeod (2012) on the comparison between the risks of upper extremity injury in both automatic and manual production lines, 21 manual and 4 automated sections in the disinfection unit of a hospital pharmacy were studied.

The result of this study showed that the score obtained from the manual section was more than that of the automated section. Fourteen manual sections had low-risk levels and 7 sections had moderate risk levels. However, the risk level in all automated sections obtained as low [10]. The ART method is introduced in 2007 by the HSE organization as a new assessment method, and it is considered as a simple and practical method for assessing jobs with repetitive tasks in the upper extremities. However, not many studies have been done using this method. One of the benefits of the ART method is that it does not require complex calculations and all aspects in assessment methods of upper extremities, such as QEC, RULA, SI, that are taken into account for the assessment of MSDs are also included in the ART method, and it is presented as an easy and practical method [5-7].

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Ethics Approval

All principals of ethics were considered in the study. Participants were satisfied to be studied and signed the consent form.

Conflicts of interest

None of the authors has any conflict of interest in this manuscript.

Author Contribusion:

MFA designed the study, analysed and interpreted the data, ZCh participated in data collection and management, ABP contributes in writing the manuscript. All authors took part in reading and approving the mauscript.

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