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Original

Study of Biomechanical Risk Factors for Musculoskeletal Disorders in the Bakery Business Based on ART and OCRA Index

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Abstract

Background: Bakery workers, Beacause of their nature, are at risk of musculoskeletal disorders caused by ergonomic factors. The purpose of this study was to evaluate the biomechanical risk factors for musculoskeletal disorders in bakery workers. **Methods:** In the current study, all tasks of sangak, taftoon, and lavash bakery in Gonabad were selected based on the census method. Next, Hierarchical Task Analysis (HTA) method was used for task analysis, and the job was degraded to tasks, actions, and movements. For the following step, the ART and OCRA method was implemented to identify common risk factors in repetitive tasks that can contribute to developing musculoskeletal disorders of upper limbs. Analysis of the results in this study was performed using SPSS 17. **Results:** According to the results study, the ART and OCRA index score for shater and chonegir tasks for all three kinds of bakeries is at high risk (red zone). In ART index score of arm movements, repetition, force, head/neck posture, and back posture for shater and choonegir task in lavash and taftoon bakery and shater task in sangak bakery is in its maximum levels. This reflects the level of red risk and indicates that in these tasks, fast arm movements, repetition, force, head/neck posture, and back posture are recognized as major occupational risk factors in these tasks. **Conclusion:** The results showed that the risk of musculoskeletal disorders owing to repetitive tasks is relatively high in the bakery and ergonomic interventions are required to redesign the job. This study shows the use of the ART method as a practical, applicable, easy, and convenient method for evaluation and ergonomics interventions in repetitive work tasks.

Keywords: Risk factors; Ergonomics; Bakery; ART index; OCRA index

Introduction

In today's industrialized world, many workers and employees have to adapt to the inadequate conditions imposed on them by the environment and the tools used and also to comply with the constraints. The consequences of such a confrontation can be very serious and have an adverse effect on a person's quality of life and health. In such a situation, people are not physically or mentally in the appropriate work environment, the type of work or equipment they use. Consequently, the continuation of this situation can lead to musculoskeletal disorders, which are among the most common and important

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causes of lost working time, increased costs, and harm to employees. According to recent research, the above disorders are the causes of more than half of workplace absences and one-third of workers' indemnification claims.[1-3] According to the NIOSH classification, musculoskeletal disorders are second to occupational respiratory disease in severity, and prevention [1]. Moreover, according to available statistics, the incidence of musculoskeletal disorders was 31% of all occupational disorders in Finland and 44% in the United States.[4] Work-related musculoskeletal disorders are caused by getting expose to a variety of occupational risk factors, including physical work-related factors (such as posture, force, movement, and vibration), psychosocial factors & individual factors.[1-5]

Beacause of a large number of repetitive movements, long-term work in a standing position, incorrect working conditions, and other factors such as psychological factors and unsuitable environmental conditions, are more likely to occur in workers in the bakery profession. Since workers have to put their bodies in certain positions during the work process, the desired or undesirable posture, the duration of holding the load, the static or dynamic work, alone or together, play an important role in increasing these disorders.[6] Therefore, preventing the occurrence of these discomforts requires the evaluation of work situations using ergonomic job analysis methods to correct work situations, if necessary. There are currently various procedures for assessing occupational exposure to risk factors for musculoskeletal disorders. The OCRA index technique is one of the most complete methods for assessing the exposure of upper extremities to repetitive movements.[7-9] The International Organization for Standardization (ISO) recommends the use of the OCRA index technique to achieve the specific objectives of the standard. One of the main reasons for this recommendation is that this method provides a detailed analysis of all major organizational and mechanical risk factors for musculoskeletal disorders associated with upper extremity work and examines all repetitive tasks involved in complex occupations. It finally assesses the overall level of risk of worker exposure.[8, 9]

The reason for choosing the OCRA method compared to other methods is the existence of special risk factors that exist in the bakery job that are dealt with in detail using this method. Addition benefits of applying this method are special importance given to return times and evaluation done for left and right hands separately. Thus, this method was selected as the most appropriate method for evaluation. However, this technique has various limitations that make it difficult to use. The fact that this technique is time-consuming, does not take into account all the psychosocial factors related to the trace area. In general, there is no comprehensive technique that can accurately identify ergonomic risk factors for musculoskeletal disorders. As a result, several techniques should be used to identify all risk factors. For ergonomic evaluation of the upper limb, various techniques including JSI (job strain index), ACGIH-HAL, CTD Risk index, LUBA, and ART techniques have been presented. Except for very limited studies that have applied OCRA and JSI techniques, other techniques have not been studied and used in Iran. In January 2007, the HSE developed a prototype tool for assessing upper limb risk in repetitive tasks, called the ART (Repetitive Task Assessment).[10] This tool is created for more accurate evaluation the risk of tasks that require repetitive movement in the upper limbs, especially the arms and hands. The study of Abbaszadeh et al. in Iran showed that the ART method is suitable, applicable, and easy to identify and evaluate the risk factors of repetitive tasks.[10]

McLeod et al. in 2012, used the ART method in their study to compare the risk of upper extremity disorders in manual and automatic tasks in the pharmaceutical industry. They also used the ART

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method as a suitable and practical way to identify risks related to upper limbs introduced (19-IOH). ART method can be used to screen for repetitive upper limb tasks due to physical risk factors that lead to the development of musculoskeletal disorders, increase workers' awareness of the dangers of repetitive tasks, display workers risk, provide a range of levels, use risk in evaluating tasks and contextual recommendations to improve performance. One of the strengths of this technique is that in addition to considering the effect of all risk factors and providing the final score for a task, it provides a separate assessment for each risk factor and risk level with three colors, i.e., green, yellow, and red for which point is specified. Due to the fact that limited ergonomic studies have been conducted in the bakery profession in Iran and this profession is rapidly growing in the country, this research seemed necessary. The purpose of this study was to use the ergonomic assessment methods of the upper limb to study the risk factors of musculoskeletal disorders in the bakery profession and to provide suggestions for improving the working conditions of workers in this profession.

Methods

The present study is a descriptive-analytical cross-sectional study. The study population in this study includes all bakeries in Gonabad,i.e., 7 taftoon bakeries, 9 lavash bakeries, and 12 sangak bakeries, which were studied by census method.

In general, this study uses a combination of three methods of data collection including observational method (to analyze jobs and tasks with repetitive movements), interview method (to ask about the type of work performed and the complexity of the work), and upper limb ergonomic assessment techniques (to determine the actual risk levels of repetitive tasks and evaluate them). Risk factor assessment was performed based on upper limb assessment techniques including OCRA and ART techniques. To calculate the indicators of coping with repetitive occupational activities, samples were collected using the video recording method. After analyzing different occupations and tasks and determining the coefficient related to each of the occupational risk factors, by using the instructions related to each of the ergonomic evaluation techniques of the upper limb, the value of each of the indicators, as well as the status of risk levels from the studied jobs and tasks were calculated and classified.

In the present study, all the tasks of people working in bakeries have been identified. Tasks were then subdivided into sub-tasks, sub-tasks into work cycles, and work cycles into work activities. To analyze each task of a complete work cycle of the worker's activity in the desired workstation, a photo/video was prepared according to the instructions of each method. Later, the videos were analyzed based on the mentioned techniques. Work cycles were recorded until several cycles were not repeated. Task analysis and identification of risk factors based on different techniques are briefly described in the following section:

OCRA Index

The purpose of using the OCRA method for the present study was to first analyze the performed activities and various tasks in job positions. Second, calculate the exposure index, and finally, determine the level of risk and classify it.The OCRA method (Index of Exposure to Repetitive Occupational Activities) has been proposed to analyze the exposure of workers to tasks with risk factors of various upper extremities. The purpose of this index is to determine the worker's exposure to tasks such as repetitive movements of the upper limbs. The additional goal is to categorize multiple job scenarios according to their exposure to WMSDs. In general, the OCRA index is calculated from the ratio of total technical activities performed during the shiftwork to the total number of recommended technical activities during the work shift. In the OCRA method, risk levels are divided into four categories.

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Table 1. Risk Rating Based on the Score Obtained from the OCRA Index

OCRA index score	Risk level	Zone	Type of risks
OCRA1≥	Risk level 1	Green	No risk
OCRA>12≥	Risk level 2	Green/Yellow	The risk is negligible
2OCRA> 4≥	Risk level 3	Yellow	Low risk
<OCRA4	Risk level 4	Red	Existence of risk

After specifying the work tasks, due to the repetition of the tasks, a video is randomly prepared from each task, and after reviewing the videos, the OCRA index for both hands is calculated separately. Finally, risk factors were leveled according to the OCRA index score obtained [10].

ART Index

In this method, 12 risk factors in 4 groups: 1- Repetitive movements 2- Force 3- Improper posture (neck, back, shoulder/arm, wrist, and hand) 4- Additional factors (including duty time, recovery, work speed and work environmental factors) were examined. In this study, a Hierarchical Task Analysis (HTA) was performed. Next, each job was analyzed into a task, each task into activities and each activity was analyzed into movements. In the present study, the ART method was used to investigate exposure to repetitive movements. This method is used to identify common risk factors in repetitive tasks involved in the development of upper extremity disorders.

Objectives of designing this method: 1- A tool that is fast and easy to use. 2- Be related to scientific studies and strategies for assessing the risk of upper extremity disorders (especially studies used to design repetitive tasks). 3- It has the ability to identify high-risk tasks.[11] This method is for tasks with upper limb movements, tasks that are repeated every minute or so, tasks that occur for at least 1 to 2 hours per day or shifts, tasks in which hand tools are used regularly, as well as jobs where the process of assembly, production, construction, packaging and batching is appropriate. This approach identifies repetitive tasks that pose significant risks and focuses on where control measures are needed. In order to improve working conditions, it prioritizes repetitive tasks and takes measures to reduce potential risks. In this method, risk levels are divided into three categories: green / low risk, yellow / medium risk / careful review of work, and red/high risk / require immediate action. The evaluation is done in 4 steps:

Frequency and repetition (A)

Arm movement (A1): At this stage, the movements of the right and left arm are evaluated. If the arm movements are low (relatively intermittent movements), a score of zero is given and the risk of this type of movement is in the green area. If the movements are repeated (regular movements with a certain amount of pause), a score of 3 is given and the risk of this type of movement is in the yellow area. If the move is repetitive (almost continuous), a score of 6 is given and the risk is in the red area.

Hand and arm movements repetition (A2): This step assesses the repetition of left and right arm and hand movements and does not involve the fingers. It examines the number of arm movements over a period of time (for example, per minute). Movements that are repeated 10 times a minute or less get a score of zero, and the risk of this type of movement is repeated in the area of 10 times a minute - green. If there are 20 moves, 3 points are given, the risk of this type of move is in the yellow area. Movements that are repeated more than 20 times per minute are given a score of 6, which puts the risk of such movements in the red area.

Force (B)

In this step, we first determine the amount of force applied by hand using the relevant table and then refer to another table. Depending on the duration of the force, we determine its level of risk. If more than one kind of force is applied, the highest score of the table must be selected.

3. Inappropriate postures (C): This step evaluates the length of time a worker is in a particular posture.

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Head/neck posture (C1): At this stage, the head/neck posture is evaluated in such a way that if there is a clear angle between the neck and back while performing the task, twisting and bending is observed in the neck. The scoring method is that if the person is in a normal posture, zero points are given. If there is bending or rotation in 15 to 30% of the working time, 1 point is given and if more than half of the working time bends or rotates are to be seen, a score of 2 is given.

Back posture (C2): In this step, the back posture is evaluated. If more than 20 degrees of rotation and bending are observed, the posture of the back is considered inappropriate. The scoring at this stage is such that if the posture is almost normal, zero points are given. If less than half of the time his work is seen forward, two sides or rotation, 1 point, and if more than half of the time there is bending forward, two sides or rotation, 2 points are given.

Arm posture (C3): In this step, the posture of both arms is evaluated. If the arms are kept close to the body or have a support, a score of zero is given; if less than half of the working time (15 to 30%) the arms are away from the body without support, a score of 2; and if more than half of the time something is placed in this posture, 4 points will be allocated.

Wrist posture (C4): In this step, wrist posture in both hands are evaluated. If there is a certain angle in the wrist, bending or deviation is observed in the wrist. The scoring method at this stage is that if the wrist is almost straight / in a normal and neutral position, a score of zero is given; if a section of working time (15 to 30%) the wrist is bent or deviated, 1 point, and if more than half of the time the wrist is bent to the point of deviation, 2 points are given.

Hand/finger grip (C5): If the grip is strong (power grip) or proper, the score is zero; if less than half of the working time (15 to 30%) pinch or wide finger grip, a score of 1, and if more than half of the working time, a score of 2 is given.

Additional factors (D)

Breaks (D1): Determines the maximum length of time that people perform repetitive tasks without interruption. Breaks are considerable for changes or pauses (for example, at least 5-10 minutes) in arm and hand activity. These breaks contains time spent eating as well as performing tasks other than repetitive tasks (eg. visual inspection tasks). If the worker completes a task without interruption in less than one hour, or if he has frequent short breaks (at least 10 seconds) every few minutes throughout the work period, we give a score of zero. If one hour is less than 2 hours, 2 points are given. If 2 hours is less than 3 hours, 4 points are given, if 3 hours are less than 4 hours, 6 points are given. Finally, if it is more than 4 hours, 8 points are given.

Speed of work (D2): This step is to ask the workers about any problems they may have in the continuation of the work. If they have no problem continuing to work, they are given a score of zero, if they sometimes have difficulty continuing to work, they are given a score of 1, and if they often have difficulty continuing to work, a score of 2 is given.

Other factors (D3): In this step, other factors present in doing the work for both hands are identified. For example, gloves that make it difficult to grasp and perform a task, a tool (eg. hammer, pickaxe) that is used for 2 or more strokes per minute, a hand used as a tool (hammer), and 10 strokes or more per hour beats, tools, workpieces, or workstations that put pressure on the skin, hand-arm contact with vibration, etc. The scoring method at this stage is that if none of these factors exist, a score of zero is given, if one of these factors exists, a score of 1 and if there are 2 or more factors, a score of 2 is given.

Duration (D4): Determines the length of time a worker performs repetitive work in a routine or daily shift (excluding breaks). At this stage, if the duration of the worker's duty is less than 2 hours, it is multiplied by 0.5 and the score is calculated. If it is 2

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to less than 4 hours, it is multiplied by 0.75; if 4 to less than 8 hours, it is multiplied by 1, and if it is more than 8 hours, it is multiplied by 1.5 and the score is calculated.

Psychosocial factors (D5): These factors are not given any points. However, they should be considered and, if present in the workplace, recorded on the scoring sheet. Psychosocial factors must be considered through discussion with workers. These factors are: there is little control over how the work is done, careless doing the work and finishing quickly, monotonous work, requiring high levels of attention and concentration, repetition of short intervals, lack of support from colleagues and supervisors, excessive work needs and lack of enough training to do the job.

To calculate the score of the evaluated task, we add the scores of steps A1, A2, B, C1, C2, C3, C4, C5, D1, D2, and D3. If we want to evaluate both arms, we have to calculate the points of the right and left arms separately. To calculate the exposure point of a worker performing a task, the score of that task must be multiplied by the time factor.

Exposure Score = Task Score * Time Coefficient (D4)

Task scores and exposure time scores help to prioritize tasks that require immediate attention and to evaluate the effectiveness of any corrections made. If the exposure score is between 0 and 11, the risk is low. Although the exposure score is low at this stage, the condition of vulnerable groups such as pregnant mothers, new workers, and workers who have to work hard in repetitive movements should be considered. If the exposure score is between 12 and 21, the average risk level should be expressed and further review of working conditions is required. If exposure score is 22 or higher, the risk level is high and more research is needed. If there is work rotation in the workplace and each worker has to do several repetitive tasks during the work shift, to assess the level of exposure, the exposure score of the individual in each of the tasks should be calculated separately by ART method and the final exposure score should be given. In this study, in order to assess the risk of repetitive work using the ART tool, the ART score sheet was completed for each of the bakeries and the work risk in each of the bakeries was determined.

Results

The results of the ergonomic evaluation of different types of bakery profession by right and left hand based on OCRA and ART indices are shown in Tables 2.

Based on the results of Table 1, the OCRA index for employees working as chonegir and shater of lavash bakery, sangak bakeries shater, as well as chonegir and shater of taftoon bakeries is more than 4 (red zone). The OCRA index for employees working as bakers in all three types of bakeries is at level 3 (yellow zone) and with low risk. Comparing the results of Table 2 with Table 1 shows that the index score for all people working in bakeries is at least 3 and all people are at musculoskeletal disorders risks. The results of biomechanical risk factors for musculoskeletal disorders in lavash bakery staff based on ART index are shown in the table below.

Based on the results of this study, the ART index score, except for nangir tasks, which is in the range of 12 to 21 and is actually at a moderate risk level, shater and chonegir tasks in all 3 types of bakeries are more than 22 with high risk. The results of the correlation study of the results of the OCRA index and the ATR method in determining the ergonomic status of bakery workers are shown in the table below.

The results of the Spearman correlation test indicates that there is a statistically significant relationship between the results of the OCRA index and ATR method in determining the ergonomic status of professionals in all three types of bakery and this correlation with the ATR index in Lavash bakery is about 0.85.

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Table 2. The Score of Biomechanical Risk Factors of Musculoskeletal Disorders of Bakery Staff Based on OCRA Index

Type of Bakery		Lavash Bakery			Sangak Bakery		Tafton Bakery		
Tasks		Chanegir	Shater	Nangir	Shater	Nangir	Chanegir	Shater	Nangir
index OCRA	Right Hand	8.35	8.62	3.33	7.95	3.19	7.85	8.61	3.25
	Left Hand	4.9	5.5	3.02	4.30	3.00	4.81	5.21	3.05

Table 3. Risk Factors for

Index coefficients		Lavash Bakery			Sangak Bakery		Tafton Bakery		
		Chanegir	Shater	Nangir	Shater	Nangir	Chanegir	Shater	Nangir
A1	Right Hand	6	6	3	6	75.3	6	6	3
Arm movement	Left Hand	50.4	25.5	3	18.5	3	25.5	25.5	3
A2	Right Hand	6	6	3	75.5	75.3	6	6	3
frequency	Left Hand	62.5	50.4	3	90.4	25.3	6	62.5	3
B	Right Hand	8	8	4	8	66.4	8	8	4
Force	Left Hand	50.6	6	4	90.6	4	50.7	7	4
C1	Right Hand	2	2	1	2	41.1	2	2	1
Head / neck posture	Left Hand	2	2	1	81.1	1	2	2	1
C2	Right Hand	2	50.2	87.1	2	91.1	2	25.2	87.1
Back / waist posture	Left Hand	2	2	37.1	2	08.1	2	2	1
C3	Right Hand	75.2	2	75.2	4	2	2	3	75.1
Arm posture	Left Hand	75.1	62.1	50.1	4	4	2	50.1	62.1
C4	Right Hand	2	75.2	50.0	2	2	2	75.2	25.1
Wrist posture	Left Hand	62.1	62.1	12.1	2	2	2	50.1	37.1
C5	Right Hand	12.1	87.1	87.0	2	25.1	1	2	62.0
Hand / finger posture	Left Hand	1.12	2	87.0	81.1	1	12.1	87.1	75.0
D1	Right Hand	1.12	37.1	87.0	2	33.1	42.1	50.1	75.0
Rest times	Left Hand	37.1	50.1	87.0	90.1	1	87.1	5	62.0
D2	Right Hand	87.1	12.1	0	2	33.1	57.1	62.0	25.0
Work speed	Left Hand	62.1	1	0	2	50.0	62.1	62.0	25.0
D3	Right Hand	75.1	87.0	62.0	2	58.1	71.1	75.0	62.0
Other factors	Left Hand	62.1	87.0	62.0	2	1	75.1	50.0	75.0
D4	Right Hand	1	1	1	1	1	1	1	1
Duration	Left Hand	1	1	1	1	1	1	1	1
Task Score	Right Hand	87.34	62.35	25.18	38	16.27	71.33	87.34	62.17
Score	Left Hand	30	25.28	12.17	81.34	1	50.32	87.28	12.17
Task	Right Hand	87.34	62.35	25.18	38	16.27	71.33	87.34	62.17
ART	Left Hand	30	25.28	12.17	81.34	16.17	50.32	87.28	12.17

Biomechanical Musculoskeletal Disorders in Bakery Workers Based on ART Index

Table 4. Correlation Between OCRA Index Results and ATR Method in Determining the Ergonomic Status of Lavash, Sangak, and Taftoon Bakery Workers

	Type of Bakery	ATR		
		Tafton Bakery	Sangak Bakery	Lavash Bakery
OCRA	Spearman correlation coefficient	851.0	518.0	365.0
	P-Value	>0.001	>0.001	012.0

Discussion

Based on the results of Table 1, the OCRA index for people working as chonegir and shater of lavash bakeries, shater of sangak bakeries as well as chonegir and shater of taftoon bakeries is more than 4 (red area). The OCRA index for employees working as nangir in all 3 types of bakeries is at level 3 (yellow zone) and with low risk. Comparing the results of Table 2 with Table 1 shows that the index score for all people working in bakeries is at least 3 and all people are at risk for musculoskeletal disorders. The results of the ART index showed that except for nangir tasks for which the OCRA index score is in the range of 12 to

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21 and is in fact at a moderate risk level, the score of shater and chonegir tasks in all 3 types of bakeries is more than 22. According to the guidelines, the ART index is at a high-risk level. The results of Tajvar et al.'s study showed that the most cumulative disorders due to shoulder CTD trauma are related to shater task and the highest wrist & back CTD is related to chonegir task.[12] Another study by Tajour et al. stated that 56.5, 67.4, 77.3, and 75% of the total workload in Taftoon Dvar, Traditional Taftoon, Sangak, and Baket bakeries are in the red or danger zone, respectively. It further revealed that the risk level of chonegir and shater tasks in all four types of bakeries, as well as the risk level of nangir tasks in sangak and baguette bakeries and the nangir / sales task in sangak bakery, are in the red or danger zone.[11] Accordingly, it is suggested to use the redesign method to improve their working conditions.

Besides, in a study, the effect of educational interferences on first aid and ergonomics on improving the performance of bakery workers related to occupational hazards in Zagazig city was done by Samia and the results showed that 55.1% of bakers face problems with musculoskeletal disorders.[13] In another study by residents and colleagues on 120 bakery workers in Sanandaj using the Nordic questionnaire, a high prevalence of musculoskeletal disorders was observed among bakery staff, and the need for ergonomic control methods was suggested.[14] Additionally, Yi-Lang Chen (2020) assessed the symptoms of musculoskeletal disorders using the Nordic questionnaire among Taiwanese bakery workers, and the results showed that musculoskeletal disorders in every part of the body was 93% among respondents the last year. With the highest prevalence of 66.3% and 51.8% in the hand/wrist (right and left) followed by the prevalence of 50.6% and 45.8% in the shoulders (right and left) and lower back (2/2), 48٪.[15] Hamid Mehri et al. assessed the risk of musculoskeletal disorders in bakers working in traditional bakeries in Sabzevar using the Nordic and RULA questionnaires. The lower limb belongs to the knee (50%). In the RULA evaluation, 33.34% of the subjects obtained a score of 7 (with a level of corrective action of 4) and 55% of individuals with a score of 5 and 6 (with a level of corrective action of 3). It was concluded that they work ergonomically (88.3%).[16] Prevalence of musculoskeletal disorders and evaluation of ergonomic factors in people working in traditional bakeries in Hamadan city were also studied by Turkman et al. Based on the results, the prevalence of musculoskeletal disorders in the limbs of the knees, middle and lower back, shoulders and wrists in workers - baking traditional bread was reported to be high. The organs involved in this job were: neck, shoulders, back, waist, elbows, arms, hands, thighs, knees, and legs, and ankles. The highest prevalence of pain in workers obtained were: in the middle of the back (92.68%), knees (80.49%), shoulders (30.95%), forearms (26.19%), and wrists (26.19%).[17]

Similarly, Afshari performed a long-term evaluation of arm position and arm movement and their relationship with the discomfort of perceptible symptoms among bakery workers on 57 bakers from three types of bread baking systems (sangak, taftoon, and tanuri baking systems). The results showed that bakery workers, especially sangak bakers, may be exposed to high levels of physical exposure. According to the study results, in addition to the high levels of physical exposure, poor workstation design and improper hand tools may be the main risk factor for shoulder disorders among bakers.[18] In a study of 172 bakers in Kumasi, Ghana, ergonomic hazards (standing, sitting, and bending frequently) were observed.[19] A national survey of Lebanese bakery workers by Rima R. Habib et al. (2019), from 504 bakeries showed that 23% of bakery workers reported upper limb pain.[20] Accordingly, all of the above studies are consistent with the present study and show the high prevalence of musculoskeletal disorders among bakers. In the study of Beheshti et al. the

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potential risk of musculoskeletal disorders in bakers was assessed using the LUBA and ACGIH-HA methods. Also the results indicated a high risk of musculoskeletal disorders due to repetitive tasks, which is consistent with the present study. The highest relative discomfort scores noticed in the back were nangir and shater at tafton bakeries whereas chonegir faced discomfort in the neck and shoulders. The highest relative discomfort score for shater, chonegir and nangir of lavash bakery staff was in the waist and neck area. Contrarily, shater and nangir of sangak bakeries reported discomfort in the elbow and wrist area.[21] Besides, in another study by Beheshti et al., except for chonegir in sangak bakery, the right-hand strain index score for all tasks in lavash, taftoon, and sangak bakeries was more than 7 (red area). A statistically significant relationship was obtained between the results of OCRA and JSI in determining the ergonomic status of bakery workers in all 3 types of lavash (P <0.001 and r = 0.545), taftoon (P <0.001 and r = 0.51) and sangak (P <0.001 and r = 0.461).[22]

In the study of Mousavi et al., the results of the evaluation of risk factors related to musculoskeletal disorders in the textile factory by OCRA method showed that 0.86 of low-risk work tasks, 87.93% of medium-risk work tasks, and 11.21% of work tasks are of high risk. Therefore, the OCRA method can be used to assess for musculoskeletal disorders of the upper extremities in repetitive tasks in the textile factory.[23] As mentioned earlier, the purpose of ART analysis is to accurately assess the status of work. Risk factors, when performing tasks with high repetition, either directly cause damage to the upper limbs or aggravate complications. Based on the results of Table 3, scores related to arm movements (A1) and repetition (A2) obtained for chonegir and shater of lavash and taftoon bakeries, as well as shater of sangak bakery were equal to 6, which indicates the level of red danger and that in these tasks arm movements are very frequent, and that repetition and rapid movements are considered as one of the occupational risk factors for these tasks. Repetition and arm movements in the nangir task in all 3 types of bakeries examined are about 3 (frequent), which is related to the danger level of yellow. In addition, the power score (B) for chonegir and shater of lavash and taftoon bakeries, as well as shater of sangak bakery, is at the level of red danger. Head / neck and back/waist posture scores of people who work as chonegir and shater in lavash, taftoon, and sangak bakeries are at a red risk level, indicating that the neck is in a bent or twisted position and that the back rotates or bends sideways or forward for more than half the time of the work.

Lunar et al.'s study showed that 42% of work postures of bakery workers in Arak are inappropriate. They claimed that 5.1% of people have dangerous flexion while working, 4.3% have dangerous torso rotation and 2.8% have dangerous and harmful rotation and flexion.[24] In the study of Kuhpayi et al., in a manufacturing company, the ART method was used to evaluate ergonomics and the total ART score was 30.7-07.43. Data analysis by ART method displayed that 74.6% of 240 cases were at a high level and 13.8% at a medium risk level. The results showed that the ELECTRE method can be used successfully for ergonomic engineering challenges and human factors.[25] The arm posture score is only at the red hazard level in the sangak shater and at the yellow hazard level in other tasks and bakeries. The wrist posture score (C4) indicates that, except for people working as nangir lavash bakers, people working in a variety of bakery tasks have bent and twisted wrists for more than half of the time. Based on the results of this study, the score related to rest times for shater and chonegir people is at the level of yellow risk and it can be considered as a risk factor to some extent, but it is at a lower level than other risk factors. For the nangir task in all the bakeries surveyed, the maximum length of time a person works without interruption is less than one hour and there are several short breaks every few minutes.

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The speed rating for chonegir lavash and taftoon bakeries and shater sangak bakery is at the red risk level. Score D3 (other factors) for chonegir lavash and taftoon bakeries and shater sangak bakery is at the red risk level and indicates that in addition to the risk factors examined in this index, there are other factors in the task that may lead to skeletal disorders. Among other factors in these tasks are insufficient light level, the need for precise hand movements with the fingers in the task, and the presence of tools and workpieces that cause discomfort or cramps in the hands and fingers. In addition to the mentioned risk factors, psychosocial factors such as monotonous work, lack of support from supervisors and colleagues, lack of motivation to eliminate breaks or finish work earlier are also examined in this method, but not scored in the ART index. In fact, it is one of the limitations of this method.

According to the findings, most of the work tasks studied are in medium and high-risk levels. Thus, further studies to examine control and preventive measures to improve working conditions, especially in eliminating or reducing the impact of risk factors, i.e., A1 (arm movements), A2 (Repetition), B (force), and C1 (neck posture) are necessary, as workers who perform these tasks will have the potential to develop musculoskeletal disorders if they continue to work. In all work tasks, risk factors "A1 (arm movements), A2 (repetition), B (force) and C1 (neck posture)" are at the highest risk level, indicating that the effect of these two factors on the high risk of these tasks compared to other factors have priority. Therefore, it is necessary to take any action as soon as possible to reduce or eliminate the impact of these factors on workstations.

The results of the Spearman correlation test showed that there is a statistically significant relationship between the results of the OCRA index and ATR method of all 3 types of bakeries and this correlation with the ATR index in lavash bakery is about 0.85. According to the study conducted by Mehdi Mohammadian, through the evaluation of 30 tasks in poultry slaughter, assembly, and container production industries, the highest agreement, and correlation were obtained between ART and OCRA methods,[26] which is consistent with the present study. Based on the results of this study, it can be concluded that most people who work in this type of bakery are prone to musculoskeletal disorders and considering that musculoskeletal disorders are one of the most common and important issues. Occupational injuries are one of the main causes of disability of workers and because these disorders have the property of accumulation over time and are exacerbated by aging and physical and mechanical stress and with considering that most of the bakers studied are young and have little work experience, we must think of ways to improve this situation. Certainly, the best method to use is ergonomic control. Ergonomics is considered in every program and it's effective in reducing the rate of musculoskeletal disorders. Work-related musculoskeletal disorders have also been proven so far.[9, 27] Among the ergonomic corrections that can be done to improve the work environment can be the following:

Considering the appropriate work table with the work needs and body dimensions of bakers, using anti-fatigue flooring, using electric shater machine, using appropriate and ergonomic tools, such as using ergonomic spatula when cutting the dough in the bakery, educating bakers about musculoskeletal disorders and methods of preventing them and using management methods as well as taking into account work rotation or taking short breaks.

Also, it is suggested that the following be done to reduce musculoskeletal complications in bakery workers. Redesigning various bakery jobs so that workers can carry out their work activities easily and without doing extra or dangerous movements. To prevent excessive bending and twisting of the trunk in

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shaters and chonegirs, the distance between access to the dough and work tools should be shortened. In such a way, the dough tank and work tools are close to the worker and at the same time the tank or container containing dough is on the platform or pallet so that the worker does not have to bend and twist a lot (preferably the pallet or platform is adjustable). For nangir, to prevent discomfort in the lumbar and knee area, the standing-sitting method should be used, which can be used with suitable chairs such as horse saddle chairs.[24] To prevent disorders caused by arm movement in the shoulder area, especially in chonegir and the shater needs to be slightly lower than the shoulder height of the spreader. To prevent bending and twisting in the lumbar posture that may lead to lumbar disturbances that occur due to the large distance of the platform or table or tray containing chane (longitudinal and transverse), the longitudinal and transverse distance of the platform with chonegir worker should be appointed appropriately. Moreover, it is essential to reduce work time and implement work and rest programs so that the worker has more rest at regular intervals. Due to the low level of workers' awareness in observing the ergonomic principles of workers, training and informing them about the correct way of doing work, appropriate postures, the importance of rest breaks, load shifting can have a significant impact on preventing labor injury. Occupational examinations are also recommended for the rapid and early diagnosis and treatment of musculoskeletal disorders and appropriate exercise. Because many studies have shown that using a combination of these methods has led to better results it is suggested that a combination of these methods be used to improve the work environment in the bakery profession.

Conclusion

In summary, according to the presented materials, most of the risk factors are at an undesirable level of risk, and the results of the OCRA and ART index of bakery workers are at a high level in terms of the risk of musculoskeletal injuries and with ergonomic and pedestrian intervention. Ergonomic principles with the use of standard equipment, correct changes in the way of work, modification of tools and work positions can make the work more efficiently and optimally in which the least damage to the musculoskeletal system is done and As a result, it avoided many costs and injuries as well as absences from work.

Conflict of interest

No case reported by the authors.

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References

1. Mosavi Najarkola S. Effect of age on the prevalence of musculoskeletal disorders in workers in textile factories in Ghaemshar. Payesh. 2007;5(2):109-17.[Persian]
2. Larson BA, Ellexson MT. Blueprint for ergonomics. Work. 2000;15(2):107-12.
3. Choobineh A. Posture evaluation methods in occupational ergonomics. Tehran: Fanavaran; 2007:1-27.
4. Marras WS, Karwowski W. Fundamentals and assessment tools for occupational ergonomics. US: CRC Press; 2006.
5. Choobineh A, Tabatabaei SH, Mokhtarzadeh A, Salehi M. Musculoskeletal problems among workers of an Iranian rubber factory. Occupational health. 2007;49(5):418-23.
6. Tehran AEM. Body mechanics and principles of work station design (Ergonomics). Tehran: Omid Majd; 2007. P:253-7. [Persian]
7. Jalali A, Nasl Seraji J. The ergonomical study of the postures of doing in tailors, shoe makers, saddlers and carpet makers by ocra

[DOI: 10.18502/aoh.v5i2.6196]

analysis method. Scientific journal of forensic medicine. 2006;12(1):8-13.[Persian]
8. Apostoli P, Sala E, Gullino A, Romano C. Comparative analysis of the use of 4 methods in the evaluation of the biomechanical risk to the upper limb. Giornale italiano di medicina del lavoro ed ergonomia. 2004;26(3):223-41.
9. ILO, IEA. Principles of human factor review (ergonomics). Tehran: Arjmand Publication; 2012.[Persian]
10. Tajvar AH, Hasheminejad N, Jalali A, Ghashghav HR. Evaluation of risk factors causing work-related musculoskeletal disorders (WMSDS) in kerman bakery workers by OCRAIndex method. Iran occupational health. 2009;6(3):44-51.[Persian]
11. Tajvar A, Hasheminejad N, Bahrampour A, Chubineh A, Jalali A. Musculoskeletal disorders among small trades workers: A survey in the bakeries. Hormozgan Medical Journal. 2012;15(4):304-10.[Persian]
12. El-Ghany GM, Mahmoud SF. Effect of educational intervention about first aid and ergonomics on improving bakery workers' performance related to occupational hazards at Zagazig City. Egyptian nursing. 2019;16(1):10.
13. Saedi C, Dastaran S, Madadi Zadeh F. Prevalence of musculoskeletal disorders among bakery staff in Sanandaj. [POSTER] at: 9th national conference on occupational health and safety.2015 June. 20-21;Iran, Yazd: Shahid Sadoughi University of Medical Sciences and Health Services;2015.
14. Chen Y-L, Zhong Y-T, Liou B-N, Yang C-C. Musculoskeletal disorders symptoms among taiwanese bakery workers. International journal of environmental research and public health. 2020; 17(8):2960.
15. Khamirchi RA, Rakhshani MH, Malihi A, Mehri H, Ahmadi Asour A. Assessment of Musculoskeletal Disorders Risk in Traditional Bakers of Sabzevar, Iran (2012). Quarterly journal of sabzevar university of medical sciences. 2014;21(5):942-50. [Persian]
16. Motamedzade Torghabeh M, Torkaman J, Attari SQ, Golzar Khojasteh B, Ghafari ME, Saadatfar A. An enquiry into the prevalence of musculoskeletal disorders and ergonomic risk factors among Hamadan-based bakers in 2017. Birjand university of medical sciences. 2018;24(4):313-23.[Persian]
17. Afshari D, Dianat I, Joudaknia L, Nourollahi M. Long-term assessment of upper arm posture and motion and their association with discomfort perceived symptoms among bakery workers. 2019.
18. Bonsu WS, Adei D, Agyemang-Duah W. Exposure to occupational hazards among bakers and their coping mechanisms in the Kumasi Metropolis of Ghana. Cogent medicine. 2020.
19. Habib RR, El-Harakeh A, Hojeij S. Musculoskeletal pain among bakery workers in Lebanon: a national survey. Cogent Engineering. 2019;6(1):1608669.
20. Beheshti MH. Evaluating the potential risk of musculoskeletal disorders among bakers according to LUBA and ACGIH-HAL indices. Occupational health and epidemiology. 2014;3(2):72-80.
21. Beheshti MH, Mohammadzadeh F, Sadeghi A, Aghababaee R. Determination of biomechanical risk factors of musculoskeletal disorders in bakery profession based on JSI and OCRA indices. The horizon of medical sciences.2015;21(4):89-96.[Persian]
22. Nasl Seraji J, Mosavi SA, Shahtaheri SJAD, Pourmahabadian M. Surveying risk factors featuring upper extremity musculoskeletal disorders by OCRA method in a textile factory. School of public health and institute of public health research.2005;3(4):51-60.[Persian]
23. Ghamari F, Mohammadbeigi A, Khodayari M. Work stations revision by ergonomic posture analyzing of Arak bakery workers. Advances in medical and biomedical research. 2010;18(70):80-90.[Persian]
24. Khandan M, Koohpaei A. Ergonomics risk management in a manufacturing company using ELECTRE. Health scope. 2016;5(4).
25. Motamedzade M, Mohammadian M, Faradmal J. Comparing of four ergonomic risk assessment methods of HAL-TLV, strain index, OCRA checklist, and ART for repetitive work tasks. Iranian journal of health, safety and environment. 2019;6(3):1303-9.
26. Gordon C, Johnson EW, Gatens PF, Ashton JJ. Wrist ratio correlation with carpal tunnel syndrome in industry. American journal of physical medicine & rehabilitation. 1988;67(6):270-2.
27. Silverstein B, Clark R. Interventions to reduce work-related musculoskeletal disorders. Electromyography and kinesiology. 2004;14(1):135-52.

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