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Original

Evaluating the Potential Risk of Musculoskeletal Disorders and Postural Loading of Task Postures in Bakery

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Abstract

Background: Bakery workers due to the nature of their job 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 this study, all tasks of baking Sangak, Taftoon and Lavash in the bakeries in Gonabad were selected based on census method, and, Hierarchical Task Analysis (HTA) method was used for task analysis and job was degraded to tasks, actions and movements., LUBA and OCRA method was implemented to identify common risk factors in repetitive tasks that can contribute to develop musculoskeletal disorders of upper limbs. Finally, the results were analyzed using SPSS 17. **Results:** According to the results of this study, the score of OCRA index for employees as Chanegir (a person who makes dough balls) and baker investigated in 3 types of bakery was more than 4(red area). In general, LUBA score was obtained more than 10 for the 83.33% of workers in Tafton bakeries, 100% of Sangak bakery employees and 91.66 % of workers in Lavash bakery. LUBA score for any samples was not below 5 (action level one). Highest relative discomfort score for Nangeer (a person who takes bread out of oven) and baker of Tafton bakery was in back area and in Chanegir was neck and shoulder area. Highest relative discomfort score in Shater, Chanegir and Nangeer of lavash bakery is was lumbar area and neck and in Shater and Nangire of Sangak bakery was in elbow and wrist area. The correlation results of OCRA index and LUBA in Lavash, Sangak and Taftoon bakery were 0.26, 0.03 and 0.24 respectively. **Conclusion:** The results showed that the risk of musculoskeletal disorders due to repetitive tasks was relatively high in the bakeries and ergonomic interventions were required in order to redesign the job.

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

Introduction

Musculoskeletal disorders are one of the most important causes of disability due to work and disability in workers.[1] Musculoskeletal disorders associated with work are considered as one of the most important health problems, disabilities and absenteeism in developed societies, accounting for about one-third of the cost of health care.[2] Studies in Europe show that

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musculoskeletal disorders have a high effect on work absences, for example, in UK in 2007 and 2008, on average, each person suffering from upper limb disorders was 13.3 days absent from work, for backache 17 days and for lower limbs 17.2 days.[3] There are several risk factors for musculoskeletal disorders including repetitive work, duration of work, vibration, inappropriate, tedious and painful situations, moving heavy equipment , lifting heavy things, standing for a long time and walking long distances.[4]

Among the risk factors mentioned above, repetitive work is the most common and widespread risk factor and bad condition is the most important factor.[5] When a job is in a situation where recurring work activities become more than capacity and ability of the worker, such activities will cause a lesion. Trauma caused by repetitive movements of the organ, as it has been mentioned, has a cumulative or aggregative feature that progresses over time and shows long-term effects as injuries affecting the musculoskeletal system.[6] According to recent studies, more than half of the workplace absences and one third are job loss request.[7,8] Work-related musculoskeletal disorders due to exposure to risks are caused by several occupational factors, among which physical work (such as posture, force, movement and vibration), psychosocial factors and individual factors can be mentioned.[9,19] Musculoskeletal disorders develop as a result of excessive biomechanical burden and have a significant socioeconomic role due to the fact that it is one of the major causes of disability and absenteeism. The risk factors of these disorders are multifactorial that are still not completely clear in some aspects.[10] Labor pattern is one of the factors affecting musculoskeletal disorders.[11] The baker's job is one of the jobs that due to the special nutritional diet that exists in our country (people eat bread in almost all meals), has led to a large number of people working in this area. Since the workers have to put their body in a special position during the work period, the desirable or undesirable posture, the duration of the work, the static or the dynamic of the work, alone or in combination, plays an important role in increasing this disorder.[12]

Evidence is that many musculoskeletal disorders are preventable.[13] In fact, prevention is an effective means of reducing disorders, and measures such as screening and monitoring in the workplace are successful tools for prevention. There are currently several ways to assess occupational exposure to the risk factors for musculoskeletal disorders. In assessing stresses from posture, observational methods are most widely used in industries, including OWAS, RULA and REBA.[14] In observational methods, articular posture is scored on the score of discomfort, and the postures in which the joints have the most deviations from the normal state have the highest scores. The number of risk factors that are evaluated by each of these techniques is very diverse. Some of these techniqueslike LUBA method, merely evaluates the posture of different parts of the body, while some other important physical factors, such as force, repetitive motion, etc., should also be evaluated. The strengths of the LUBA method is that it shows some perceptions about job postures in general, it's easy to make, scoring is based on physiological data, numerical output in this way makes it easier to make decisions than the qualitative results andit also requires close contact with workers for diagnosis of confrontation. Due to the fact that there were limited studies in ergonomics in Iran related to the bakery profession, and this profession was rapidly growing in the country, this study was considered necessary. The present study was carried out in the bakeries of Gonabad city in Khorasan Province. The main objectives of this study were to assess the risk factors of musculoskeletal disorders in the bakery profession and provide suggestions for improving the work status of the workers in this

profession. This study also aimed at prioritizing ergonomic corrections based on LUBA and OCRA indicators, assessing job postures based on the LUBA index and determining the correlation of the results of evaluation of workstations by the two methods.

Methods

This study is a cross-sectional descriptive-analytic study. The research population in this study was all bakeries in Gonabad city, including 8 Taftoon bakeries, 8 Lavash bakeries and 12 Sangak bakeries, which were studied by census method. In this study, a combination of 3 methods for collecting data including observational method (for analysis of jobs and tasks with repetitive movements), interview method (for questions about the type of work performed and the complexity of the work), and the ergonomic assessment of the upper limbs (in order to determine the true risk levels of repetitive tasks and their evaluation) were used. To evaluate ergonomic status of workstations OCRA and LUBA method were used.

LUBA method (Postural Loading on the Upper-Body Assessment) is an observational and macroscopic technique presented by Kay and Karovsky in 2001, and aims at assessing postures in the upper limbs of the body. OCRA Indicator (Index of Exposure to Occupational Repeat Activities) is considered as one of the most complete methods for evaluating upper limb end points with repetitive movements.[14-16]

To calculate the indicators of exposure to repetitive occupational activities, samples were collected using a filming method and after analyzing different occupations and tasks and determining the coefficient related to each of the occupational risk factors, using the instructions for each one, ergonomic evaluation of upper limb, the magnitude of each of the indicators, as well as risk levels of each occupation and taskswere calculated and ranked according to the instructions of each technique. In this study, all duties of bakers were identified, and then duties were sub-tasked and subordinated to working cycles and work cycles to work activities. To analyze each task for a complete cycle of work, the worker was photographed/filmed at the desired work station according to the instructions of each method and the films were analyzed according to the techniques described. Filming of work cycles continued until the time multiple cycles were not repeated constantly. In order to assess the potential risk of musculoskeletal disorders in the end part of upper limb, OCRA index was used.

OCRA method is proposed to analyze the exposure of workers to tasks with a risk of various factors in upper limbs. The purpose of this indicator is to determine the exposure of the worker to tasks such as repetitive movements of the upper limbs.[17] Moreover, for other purposes, the division of multiple job scenarios is in accordance with their exposure to WMSDs.

In general, OCRA indicator is calculated of the total proportion of technical activity actually performed during the shift to the total number of recommended technical activities during the shift.[17] In OCRA method, the risk levels are divided into four categories:

After specifying tasks, due to the repetition of some tasks from other tasks, randomly the film was produced and after reviewing the films, OCRA index was calculated for both hands separately. Finally, according to OCRA index score, factors were ranked in terms of risk.[17]

The macro-posutral LUBA method was used to determine the positional pressure index of the upper limbs and to determine the prevalence of musculoskeletal disorders. The data needed to implement LUBA method was collected through direct viewing and filming of the target people, jobs and duties. This method is a pencil-paper-viewing technique.

Table 1. Risk rating based on scores obtained from OCRA index

Type of risk	Area	Risk level	OCRA indicator score
Lack of risk	Green	Risk level 1	1 ≥ OCRA
Risk of insignificance	Green / yellow	Risk level 2	2 ≥ OCRA>1
Low risk amount	Yellow	Risk level 3	4 ≥ OCRA> 2
Availability of risk	Red	Risk level 4	4< OCRA

The physical parts to be evaluated include wrists, elbows, shoulders, neck and waist. This method is based on empirical data on perceived dysfunctions, which is expressed as a numerical ratio for a set of joints movements including hands, arms, neck and waist. Body condition is evaluated based on the angle at which the upper limbs (wrist, elbow, shoulder, neck and waist) are taken during work, by an index called postural pressure. This method is based on the amount of discomfort caused by the movements of the upper limb joints and also the quantitative evaluation of the pressure on the body posed by the posture. Then, in order to measure the status pressure index, the camera shot at the work cycle of each task using a Sony digital camera. The camera was angled at a distance of one meter, which was detectable by about three post-exposure postures. After the film was completed, LUBA method was used to determine the posture of the body that had the highest working time, or the most frequent repetition. After choosing the posture, for each limb, the movements of each joint and the angle of the joint and appropriate to that discomfort score were determined. After determining the discomfort score of each of the limbs, the total of these scores was estimated according to Formula 1.

Formula 1:

$$postural\ load\ index = \sum_{i=1}^{n} \times \sum_{i=1}^{mj} Sij$$

I: the thirteenth joint, j: j is the first joint, n is the number of points to which the score is assigned, mj is the number of movements studied in the j j, Sij: the discomfort score of ithmove from the j th joint (if the relative discomfort score is equal one, Sij = 0)

The discomfort of five body joints, including wrists, elbows, shoulders, neck and waist, was collected in a standing and sitting position. The discomfort was also measured at 5 levels of 0, 25, 50, 75, and 100% of the range of joint motion. As the joint deviation increases from its normal position, the degree of discomfort isalso increased. Finally, based on the state of pressure indicator, each person's physical condition was placed in one of four levels of corrective action.

In general, the use of LUBA method consists of five steps. At first a camcorder is used to record job postures over several cycles and then the postures for evaluation is selected. After that, movements of each joint are observed in the selected posture and the respective tables are given a discomfort score.The score of all joints is collected to achieve postural LOAD. Postures selected on the basis of the corresponding equation are calculated in the method of status bar index. and finally after calculation of status bar index, corrective action required is determined by grouping the table.

Results

The results of the ergonomic evaluation of different types of bakery job by left and right hand based on OCRA and LUBA indices are shown in Tables 3.

Table 2. A corrective action group in LUBA procedure according to the load index

Corrective action	Group
Postures with a load index of 5 or less. These posters are acceptable. Except in certain circumstances such as repetition and likelihood for a long time and similar cases, there is no need for corrective action.	Group 1
Postures with a 5 to 10-degree load index. These postures need further examination and corrective changes during subsequent examinations, but there is no need for immediate intervention.	Group 2
Postures with a load index of 10 to 15. These postures require corrective action to be taken by redesigning the work environment or working methods soon.	Group 3
Poses with a load index of 15 or more. This group of postures needs to be considered for immediate remedial action.	Group 4

Table 3. Risk Assessment of Biomechanical Factors of Musculoskeletal Disorders of Bakeries Based on OCRA Index

Taftoon Bakery			Sangak Bakery		Lavash Bakery			Type of bakery Duty	OCRA Index
Nangir	Baker	Chuckle	Nangir	Baker	Nangir	Baker	Chanegir		
3.25	8.61	7.85	3.19	7.95	3.33	8.62	8.35	Right hand	
3.05	5.21	4.81	3.00	4.30	3.02	5.50	4.90	left hand	

Table 4. Results of Occupational Postures (LUBA) Status Pressure in Bakeries

Indicator coefficients		Lavash Bakery		Sangak Bakery		Taftoon Bakery			
		Chanegir	Baker	Nangeer	Chanegir	Baker	Nangeer	Chanegir	Baker
Wrist score	Right hand	1.60	1.87	1.62	2.70	2.58	1.42	1.87	1.50
	left hand	1.00	1.12	1.00	2.18	3.00	1.00	1.25	1.25
Elbow score	Right hand	1.70	3.00	2.75	3.00	2.83	1.85	2.75	3.00
	left hand	1.50	2.50	2.50	2.27	3.00	1.00	2.62	2.25
Shoulder score	Right hand	2.50	1.75	3.00	2.00	2.00	3.00	1.50	2.50
	left hand	1.00	1.00	1.00	3.00	2.08	1.12	1.00	1.25
Neck score	Right hand	2.75	2.00	3.00	2.17	2.16	3.00	1.25	3.00
	left hand	2.75	2.00	3.00	1.00	2.00	3.00	1.25	3.00
Score the waist	Right hand	2.50	2.75	3.25	2.66	2.16	1.57	3.25	6.25
	left hand	2.50	2.75	3.25	1.00	2.16	1.50	3.25	6.25
Total score	Right hand	12.25	12.75	12.25	13.75	12.91	10.75	10.87	16.25
	left hand	8.00	10.25	9.50	12.36	10.33	7.87	9.50	13.37

Based on the results of Table 3, OCRA index for employees employed as Chanegir and bakers of Lavash, bakers of Sangak, as well as Chanegir and bakers of Taftoon is more than 4 (red area). OCRA indicator for the employed as Nangir in all three types of bakery is at risk level 3 (yellow area) with low risk. Comparison of the results of Table 2 with Table 3 indicates that the index score for all people working in bakeries is at least 3, and all individuals are at risk of musculoskeletal disorders. The highest rate of relative discomfort was in Taftoon bakery Nangir in the waist and the least in the wrist. Also, the highest relative discomfort score was found in Taftoon bakeries bakers in the waist area and in Taftoon bakery Chanegirs in the shoulder and neck area. The highest rate of relative discomfort was found in Lavash bakers, Chanegir and Nangeer in the waist and neck area. The highest rate of relative discomfort was found in slaughtered individuals and slaughterers in the elbow and wrists area. In this study, none of the samples in group 1 were subjected to corrective measures. The results of the study of occupational postures (LUBA) in the baker's staff are presented in Table 4.

Results of assessment of risk of musculoskeletal disorders in subjects assessed by LUBA method indicated that:

(A) The contact level calculated for any of Sangak, Taftoon and Lavash bakeries' occupations was not less than 5 points (priority level 1 corrective action).

(B) None of Sangak bakeries staff, 16.66% of Taftoon bakery staff and 8.33% of Lavash bakery staff under study scored between 5 and 10. Which means that further studies should be conducted and there is no need for rapid intervention (priority level of corrective action 2)

(C) 33.33% of Sangak bakeries staff, 58.33% of Taftoon bakery staff and 70.83% of Lavash bakery staff scored between 10 and 15, which means that this category requires. postural modification as soon as possible by redesigning work stations or modifying work practices (priority level 3 of corrective action)

(D) 66.66% of Sangak bakery staff, 25% of Tahtoon bakery staff and 17.87% of the Lavash bakery staff scored more than 15 points, which means that immediate changes should be made promptly (Priority level 4 of corrective action).

Table 5. Correlation between results of OCRA index and LUBA method in determining the ergonomic status of bakery workers in Lavash, Sangak and Taftoon

LUBA			OCRA
Lavash Bakery	Sangak Bakery	Taftoon Bakery	
0.24	0.30	0.26	Spearman correlation coefficient
0.09	0.03	0.07	*P*-Value

Significant level below 0.05

Overall, 83.33% of Taftoon bakery staff, 100% of Sangak bakery staff and 91.66% of Lavash bakery staff have LUBA score of over 10. The Kolmogorov-Smironov test (K-S) was used to determine the normal or abnormal measurement data. Then, Spearman test was used to determine the correlation between LUBA and OCRA scores. Results of correlation between the results of OCRA index and LUBA method in determining the status of ergonomics of bakery workers are shown in the table below.

Spearman correlation test showed that there was a significant relationship between the results of OCRA and LUBA in determining the ergonomic status of Sangak Bakery workers, and the correlation with LUBA index in Lavash, Sangak and Taftoon is about 0.26, 0.30 and 0.24.

Discussion

High prevalence of risk factors for musculoskeletal disorders, especially in neck, back and shoulders, and high status pressure index and level of ergonomic measures 3 and 4 in 83% of bakery employees are among the important findings of this study. The purpose of this study was to evaluate the posture and determine the postural pressure index using LUBA method. The results of the evaluation showed that score 10 was obtained for 83.33% of Tahftoon bakery staff, 100% of Sangak bakery staff and 66.91% of Lavash bakery staff. These results represent a high level of risk. The results of this study showed a high incidence of musculoskeletal disorders risk factors in Gonabad bakery business. More than 83% of all subjects were in the level of ergonomic measures 3 and 4 (status pressure index higher than 10). High levels of pressure stress indicate high levels of risk for musculoskeletal disorders and the need for intervention and immediate corrective action.

Based on the results of this study, OCRA index for the staff employed as Chanegir and baker in each of the 3 types of bakery was more than 4 (red area). OCRA index for those employed as Nangir in all three types of bakery was at risk level 3 (yellow area) with low risk. Comparing the results of Table 2 with Table 1 indicates that the index score for all people working in bakeries was at least 3, and all individuals were at risk of musculoskeletal disorders. In a similar study by Tajvar et al. on four types of rotary and traditional Taftoon, Sangak and Baguette bread in Kerman, the most significant OCRA index of left and right handed was related to the duty of baker in Sangak bakery, and 56.5%, 67.4%, 77.3% and 75% of all work tasks in rotary Tahfton, traditional Tafton, Sangak and Baguette were in the red zone or in danger respectively. It also showed that the level of risk of Chanegir and baker tasks in all four types of bakeries was in the red zone or risk[18] which corresponds to the results of the present study. The results of LUBA index showed that the highest relative discomfort score was Nangir in Taftoon bakery Nangirand baker in waist and the least in wrist, and in Taftoon Chanegir was in shoulder and neck area. The highest rate of relative discomfort was found in Lavash Chanegir and baker in waist and neck area. The highest rate of relative discomfort was found in Sangak Chanegir and Nangir in elbow and wrists area. A further study by Tajvar et al. in bakery profession was found on 298 CTDs in 4 areas of

neck, shoulder, arm / wrist and waist, of which 91 cases were related to chiners, 149 cases related to Shakes, 10 items of bread, 6 cases related to the seller, 42 items related to bread / seller.[19] Based on this, it is recommended to use a redesign method to correct their working conditions. In a study, Lumia et al. revealed that the upper limb had the highest incidence of waist circumference with 8.55%, and the prevalence of abdominal pain in the shoulders and waist region was higher in baker than in other occupational groups.[20] One of the main causes of increasing tension and pressure on the joints is the force applied to them. To reduce the pressure caused by excessive force, when there is no possibility of power reduction and weight loss of equipment, people can be rotated in different tasks or use more individuals in that task to divide the pressure between people.[21] By creating rest breaks, it is possible that the muscles involved have the opportunity to rest and return to the normal condition.[22] To reduce the repetition of activities per minute and also the speed of movement in stations,more people with high repeatability and automation of production are necessary part of the process.[21] The results of this study indicated that hand / wrist improper posture can be considered as a risk factor for musculoskeletal disorders. Qamari et al. study showed that 42% of job postures in bakery workers in Arak were inappropriate. And 5.1% of the people have dangerous bending and 4.3% have dangerous trunk rotation and 2.8% have dangerous and harmful rotation and bending.[23] In other studies, the impact of using ergonomic control methods in reducing musculoskeletal disorders related to wok is proved.[24,25]

In a study by Tajvar et al., the most cases of pain and discomfort were related to two areas of waist and knees, and the least reported cases were elbow, back and neck. The main cause of the high back pain was the inappropriate working conditions, bending and repeated spinning, as well as the lack of adequate resting time. The main cause of the high prevalence of pain in the knee area can be attributed to working in a standing position for a long time. It was also determined that height, age, weight, history of work, marital status, educational status, type of bakeries, and type of work duties are considered as effective factors in the prevalence of symptoms of musculoskeletal disorders. Furthermore, the results of this study showed that the prevalence of symptoms of musculoskeletal disorders reported in different parts of the body, especially in the waist, hands, wrists and knees of the bakers, was high, while the majority of participants in this study were young and had little work experience and therefore, if this issue is not addressed seriously , we will probably face a crisis in the near future.[18]

According to the findings, most of the work tasks were at medium and high risk levels, so further investigation is necessary to prevent and control measures to improve working conditions, since workers who carry out these tasks have the potential of musculoskeletal disorders if they continue this work pattern. And it is necessary to act as soon as possible to reduce or eliminate the impact of these factors on work stations. Based on the results of this study, most people working in these types of bakeries are prone to musculoskeletal disorders. Considering the fact that musculoskeletal disorders are one of the most common and important diseases that can lead to disability,[26] and since these disruptions accumulate over time and are aggravated by aging and physical and mechanical stresses, we have to think about solutions to improve this situation.We should makethe best use of the ergonomic control method, which is considered as the most important part of any ergonomic program, and its effect in reducing the amount of musculoskeletal disorders associated with the work that has been proved so far.[27,28]

It is suggested that the following steps be taken to reduce the musculoskeletal complications of bakers.

1.Redesign the bakery's job posts so that workers can do their job activities without additional, dangerous moves easily.

2.To prevent excessive bending, bending and twisting of the trunk in bakers and Chanegir, the distance between access to dough and tools should be shortened. In this way, the dough bag is close to the worker and at the same time a crate or dough containing dish should be placed on the platform or pallet so the worker is not forced to damp or twist (preferably the pallet or platform is adjustable).

3.For Nangir duties, the stance-sitting method should be used to prevent incontinence in the waist and the knee, which can be used in suitable seats such as horse saddle[23]

4.To prevent disturbances caused by movement of the arm in shoulder, especially in Chanegir and baker, it is necessary to lower the width of the device a bit lower than the shoulder.

5.To prevent bending and torsion in the posture of the waist, which may lead to disturbances in waist area, due to the large distance between the platform or the table, or the tray containing the dough balls (in the longitudinal and transverse directions), the longitudinal and cross-section of the platform is determined suitable to Chanegir.

6.Reduce the time spent doing work and the schedule of work and rest, in a way that the worker can have more rest periods at certain intervals.

7.Given the low level of workers' awareness regarding the principles of ergonomics, educating workers and informing them about the proper way of doing work, proper postures, the importance of rest periods, shifting loads can be effective in preventing labor damage. Occupational examinations are also recommended for the early diagnosis and treatment of musculoskeletal disorders. Since many studies have shown that using a combination of these methods has led to better results,[29] it is recommended that a combination of these methods be used as much as possible to improve the work environment in the bakery business.

Conclusion

In summary, according to the presented materials, most of investigated risk factors are at an unsafe level. According to OCRA and LUBA index, bakery workers are at high risk of musculoskeletal injuries, with ergonomic and pediatric intervention. Taking ergonomic principles with the use of standard equipment, making the right changes in how to do things, modifying tools and work posts can be done in a more efficient and optimal way, with the least damage to the musculoskeletal system. As a result, many expenses and injuries, as well as the absence from work will be prevented.

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Moral Confirmation

No case has been reported by the authors.

Conflict of Interests

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