Archives of Occupational Health | Volume 2 | Issue 2 | April 2018 | 128-35.

Original

Evaluation of Ergonomic Risk Factors for Musculoskeletal Disorders among Kitchen Workers

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Abstract

Background: Musculoskeletal disorders in kitchen workers are prevalent due to the nature of work and repetitive work. But few studies have been done on this profession. The RULA procedure is one of the best posture assessment methods for assessing upper limbs. The aim of this study was to evaluate musculoskeletal disorders using RULA method among Gonabad kitchen workers. **Methods:** In this descriptive analytical study, Work postures of 78 workers in all Gonabad kitchens and restaurants were recorded using the camera while working. And the most repetitive and awkward posture were chosen and analyzed using the RULA method. Data analysis was done using SPSS software and double-duplex scores were compared with R software (programming software). **Results:** The results showed that the highest postural score and level of actions at the workstations were earned at points 7 and 4 respectively which was related to the task of cleaning the kitchen. The duties of carrying the pot and pouring the material in the next ranks were high RULA privileges. The highest mean scores for each of the organs examined were neck, wrists, and trunks respectively. Also, 51.20% of all workers carried an average load of more than 11 kilograms. The highest loaded weight on duty carries the pot with an average of 30 kilograms. According to the study, 100% of Gonabad's kitchen postures should be improved. **Conclusions:** In order to prevent musculoskeletal disorders, the correction of postures and the reduction of carried load are necessary. Since ergonomic studies on kitchen workers are very limited, it is suggested that further studies on ergonomic interventions, such as the design of workstations should be performed to correct postures of the neck, trunk, and wrists of workers.

Keywords: Musculoskeletal disorders; Kitchen; RULA; Ergonomics; Upper trunk

Introduction

Musculoskeletal disorders are among the most common and costly occupational injuries and constitute the most important causes of labor disability. These disruptions are the major factor in the loss of working time, increased costs and human damages.[1-4] The US Bureau of labor statistics reported that 29% of the time lost due to accidents is related to musculoskeletal disorders.[5] And according to the World Health Organization (WHO), skeletal musculoskeletal disorders have caused job loss in developing countries.[6] In general, the causes of

Citation: Beheshti MH, Tajpuor A, Jari A, Samadi S, Borhani Jebeli M, Rahmanzadeh H. **Evaluation of ergonomic risk factors for musculoskeletal disorders among kitchen workers.** Archives of Occupational Health. 2018; 2(2): 128-35.
Article History: Received: 1 January 2018; Revised: 6 February 2018; Accepted: 9 March 2018

occupational diseases are divided into five categories, among which ergonomic and mechanical factors are inclusive. Diseases caused by ergonomic factors are musculoskeletal disorders that result from physical and mechanical risk factors including inappropriate postures, lifting and carrying heavy loads, repetitive movements, vibrations, excessive force, contact pressure, low temperature, and ultimately undesirable illumination that leads to undesirable posture.[3] According to statistics released by the statistics center of Iran and the ministry of health, 76% of workers have inadequate and unsafe posture, and it is the most important cause of work-related musculoskeletal disorders.[7] Therefore, of all the ways to assess the risk of musculoskeletal disorders, postural analysis is considered as the axis and basis for evaluation.[8] In 1999, Burdorf and Van der Beek categorized risk assessment methods for musculoskeletal disorders into three groups, including mental judgment (such as questionnaires, mental judgment and judgment scale) and observation and direct measurement.[9] Among these methods, observational methods are easier, less costly and usable for different work environments.[10] So, they are the most commonly used method.[11] The RULA method is one of these methods, which is presented by McAutmann and Kurelt 1993. In this method, the number of movements, static muscle, and force applied are evaluated.[12,13] This method is inexpensive and practical compared to other observational methods.[14] So far, studies have been conducted on the use of the RULA method in various work environments. Bao et al. compare the RULA method with another methods and showed that this method is able to detect very different working conditions.[15] Pehkonen et al., in a study, aimed at evaluating the ergonomic intervention among kitchen workers and showed that ergonomic changes reduced physical load and musculoskeletal disorders.[16] Another study in the similar industry was done by. In the year 2016, one of the staff working in the department of educational hospitals in Qazvin stated that the prevalence of neck and waist pain in the trolls and shoulders of cooks is the highest owned.[17] In Iran, ergonomic studies have been conducted in similar industries. Ghasemkhani et al., in a study on automobile workers, showed that, given the priority level of the fourth corrective action that was obtained in the postures, changes were made and the working conditions improved through interventions ergonomics should be performed promptly.[18] In a study done by Zakirin et al. on ultrasound specialists, it was concluded that the evaluation of ergonomics by RULA showed the scan of left ventricular and vascular areas, the final RULA score was 7 and 6, and action levels was 4 and 3, in which case changes and intervention of ergonomics were necessary.[19] A study by Vermesyar et al. with the aim of evaluating the RULA work status in the grocery chain stores staff concluded that the work station setting and the use of a back protector chair had an effective role on reducing musculoskeletal discomfort.[20] A study by Seyyed Sajjad Ataei and his colleague in the kitchens of educational hospitals in Qazvin suggested that the risk factors such as body mass index, ability to perform work and lifting limits could increase the incidence of musculoskeletal disorders.[17] Tajvar et al., in their study, aimed at assessing the risk factors of job-induced musculoskeletal disorders in the bakery industry using the OCRA index, showed that in general, 56.5, 67.40, 77.30 and 75% of the total tasks in rotary Tahfton, traditional taftoon, sangaku and baguette are in the red zone or in danger.[21] Lunar in his study aimed at reforming the workplaces of bakery workers in Arak by ergonomic assessment of the state of the body during work, which showed that 42.20% of the workers' posture jobs among Arak bakeries were inappropriate (stressful to very harmful) and 5.1% during the work of dangerous bending, 4.30% had a dangerous trunk rotation and 2.80% rotation and bending were dangerous and harmful.[22] The findings

of the study by Tajur et al. with the aim of evaluating musculoskeletal disorders in the bakery profession indicate that among the various tasks, the highest percentage of neck CTD with 7.10% was related to salesperson duties. Also, there was a significant relationship between the CTD of the shoulder, hand/wrist and waist with the type of bakery and type of task, and the effect of work history on the prevalence of CTD in the four areas was proved.[23] The aim of the present study was to evaluate musculoskeletal disorders in Gonabad kitchen workers by RULA.

Methods

In this descriptive analytical study, workers' postures of all kitchens and restaurants in Gonabad 78 people, including cooks, chefs, cleaning and dishwashing agents, and logistics officials were recorded during the work using a photographic and cinematographic camera. Most postures were selected and analyzed using RULA method.

The RULA method steps are as follows:

In general, the first stage is observation and registration, the second stage is scoring while the third stage is determining the level of corrective actions.

Stage One: View and Record Work:

At this stage, the organs are classified into two groups A and B: Group A Includes arm, forearm, and wrist and Group B Includes neck, trunk, and legs.

The range of movement of each body member is divided into sections, and each section is numbered so that number 1 is for the range of movement, which is the minimum risk. By increasing the score of the member's work, the risk increases. With regard to the postcard code which will be described below, we compute the A and B level privileges. We need to add points in each step. Adding two factors of physical activity and strength to score A and score B make C and D respectively:

Score C = Power score + Muscle activity score + Score A

Score D = Strength Score + Muscle activity score + Score B

The final interpretation of the rating and the determination of the levels in order to provide corrective actions are done in the following ways.

Level 1: The final score of 1 or 2 indicates that if the posture is not maintained for a long time or not severely repeated, it is acceptable.

Level 2: The final score of 3 or 4 indicates that further study in this area is necessary, and as well, changes and ergonomic intervention may be necessary.

Level 3: The final score of 5 and 6 indicates that further study of changes and ergonomic intervention is needed in the near future.

Level 4: The final score of 7 or more indicates that further study of changes and ergonomic intervention is urgently needed. Finally, after scoring and determining the level of final steps of each task, SPSS and R software were used to determine the meaning and then prioritized between tasks based on the higher score and postural correction level.

By applying the Kruskal-Wallis test, the data for the final score differed significantly ($P < 0.0005$). This means that the differences in the statistical values are prioritized and can be used to determine the highest levels of musculoskeletal risks in that task and job. Then, to determine the priority of which of the tasks with a final score, and also, the higher level of action for postural repair (binary comparisons in the final scores), the software R was used with the PMCMR package.

Results

The average scores of each of the studied organs by occupation in the kitchens of Gonabad city are shown in the following figure.

The results of this study showed that according to the RULA score, the average score in the kitchen cleaning, rinsing, dishwashing, food mixing, logging, grilling, crushing materials was 7.6.6, 6.4.5.4, 5.3, 4.9, 3.5, 3.4 Figure 1. And the average corrective actions level for the tasks listed are 4, 3.6, 3.6, 3.3, 2.9, 2.8, 2.25, and 2. Figure 2.

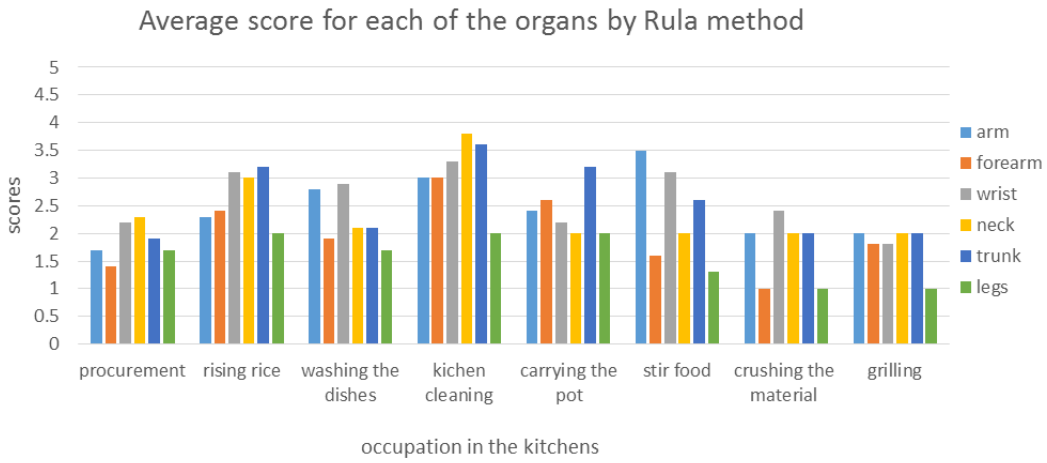

Figure 1. Average score for each of the organs examined in the RULA method

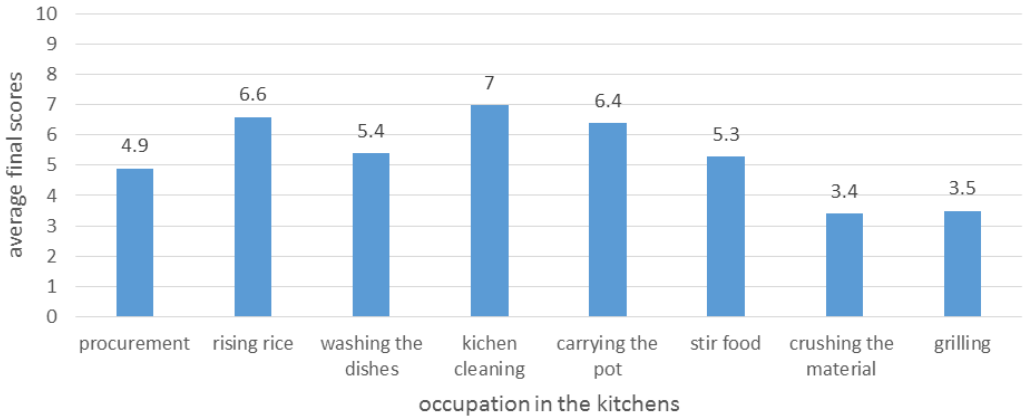

Figure 2. The average RULA method scores for each of the kitchens in the city of Gonabad

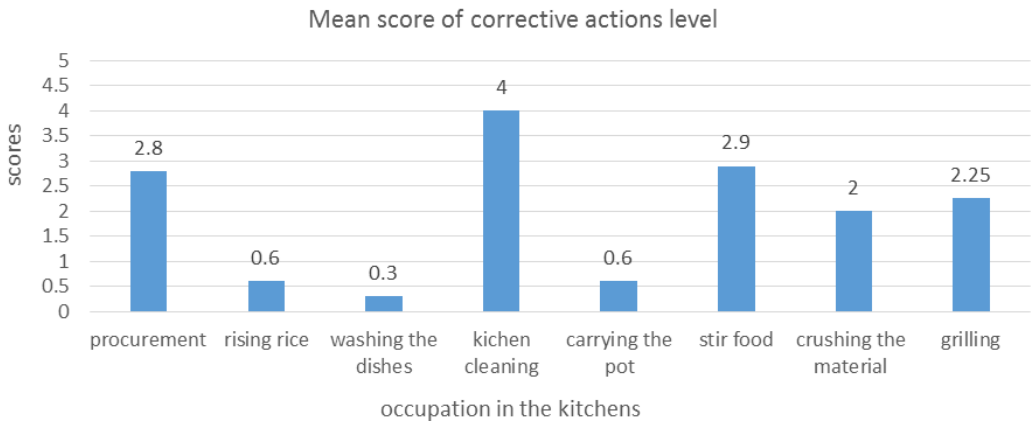

Figure 3. Mean score of corrective actions level in each of the kitchens of the city of Gonabad

The average scores of each of the organs in the assessment from the highest to the lowest are 2.9, 2.62, 2.57, 2.46, 1.96, 1.42 and are related to the neck, wrists, trunk, arm, forearm, and legs Figure 3.

The relative frequency of levels of posture correction actions is based on the information obtained from the RULA method in evaluated workers, as shown in Table 1.

Table 1. The relative abundance levels of posture correction actions

Corrective action type	Percent
1- There is no need to correct	0
2- In the near future, you must correct	35.80
3- Improvements should be made as soon as possible	20.50
4- Immediate change should be corrected	43.50

Table 2. Average load weights carried in each of the kitchens of Gonabad city

Job	Average Shipping Weight (kg)
Procurement	20
Wash the dishes	6
Rinse	8
Kitchen cleaning	0.50
Carry the pot	30
Stir food	0.90
Crushing the material	0.01
Grilling	0.30

According to the results of this study, 100% of workers' postures need to be corrected. 35.80% of people should be corrected in the near future. 20.5% of postures should be corrected as soon as possible. This study also showed that 43.5% of postures had a very high level of risk and that the worker should never work in this situation. The average total weight of loads carried by Gonabad's kitchen workers is 8.2 kg Table 2. The results of the R software after the inclusion of the final score data by applying the conover's-test are presented in Table 3. Then, the data obtained from the test in SPSS are presented in Table 4.

Based on the results of statistical analysis using R software, there was a significant difference between the task of rice rising compare to logistics task (P <0.01740). In terms of ranking averages in SPSS software, the average rice rising duty rating 41.90 was higher than the logistics, so the score is related to the task of rice rising and as a result of the high risk of diseases of the skeletal-musculoskeletal disorders. Also, comparing the tasks of logistics and washing the containers using R software showed that these two tasks were not significantly different (P> 0.005), and therefore there was no significant difference between the score and the risk of muscle-skeletal diseases.

Comparison between logistics tasks and kitchen cleaning showed that there is a significant difference between scores and the risk of musculoskeletal diseases (P = 0.00252) and the kitchen cleaning task has a higher average ranking 49.50 than logistics.

A comparison between the two duties of logistics and carrying heavy materials discovered that there is a significant relationship between the scores of these two tasks (P = 0.01162). Also, the average rating is higher for carrying heavy materials 42.90. Therefore, the risk of musculoskeletal diseases is higher than the procurement task.Furthermore, a comparison between the Procurement task and Crushing the material, as well as Procurement with grilling, showed that there was no meaningful relationship to their final scores (P> 0.00).No significant difference was found comparing the task of rinsing rice with washing the dishes, kitchen cleaning and carrying the pot (P> 0.005).

Table 3. Significance or non-significance of the difference in the final two points of the task

	Procurement	Rinse off	Wash the dishes	Kitchen cleaning	Carry a pot and ...	Stir food	Crushing materials
Rinse off	0.01	-	-	-	-	-	-
Wash the dishes	0.55	0.06	-	-	-	-	-
Kitchen cleaning	0.002	0.30	0.01	-	-	-	-
Carrying a pot and stove and ...	0.01	0.87	0.04	0.36	-	-	-
Stir food	0.75	0.037	0.77	0.01	0.02	-	-
Crushing the material	0.07	0.001	0.02	9.1e-05	0.001	0.04	-
Grilling	0.05	0.001	0.02	6.9e-0.5	0.001	0.03	0.94

Table 4. Average rating of final scores

Type of duty	N	Mean Rank
Procurement	10	26.40
Rinse	10	41.90
Wash the dishes	10	30.20
Kitchen cleaning	6	49.50
Carry a pot and ...	10	42.90
Stir food	10	28.40
Crushing the material	4	11.00
Grilling	4	10.25
Total	64	

Discussion

Based on the results of this study, the highest mean scores in all evaluated organs are related to the neck then to the wrists and trunk. According to Ataei et al. study on the kitchens of educational hospitals in Qazvin, the most prevalence of musculoskeletal disorders was reported in the lumbar region. It was predicted that the unauthorized loading conditions were due to the prevalence of these problems in this

organ.[17] The results of the studies on the extent of musculoskeletal disorders in the waist region confirm the results of the present study. Choobineh et al. study showed that 60.6% of nurses had low back pain, and 51.1% of them have experienced neck pain.[24] Also, Dehghan and colleagues reported the most discomfort in the waist 52%, knee 48% and back in welders38%.[25]

The highest average of arm score was related to the task of stirring food 3.5, forearm on kitchen cleaning 3, wick with a mean of 3.3 for kitchen cleaning, neck with 3.8 for kitchen cleaning, trunk for kitchen cleaning with an average of 3.6, as well as legs for rinse rice, kitchen cleaning and carrying a pot with an average of 2. The common reason for all these disorders, regardless of their job type, can be the long-term standing of the job group, who spend all their hours standing. Ehlers et al. also introduced long-term standing 78% of the time as the factors affecting the prevalence of musculoskeletal disorders in the kitchen staff.[26] Other studies have suggested long-term stretches, transport of loads and undesirable posture of the body as factors of the prevalence of disturbances that are consistent with the present study.[27-29] According to the results of this study, in the kitchen cleaning task, neck pain is the most common cause, which can be attributed to severe tensile /flexural and static conditions during work and carrying loads. The highest incidence of shoulder pain has also been reported in the task of stirring food that stirring the food repeatedly with big handles can be a cause of discomfort in this job .[17] 51.2% of workers carried weight weighing more than 11 kilograms. Also, the highest amount of loaded cargo was in the duty of carrying pot with an average of 30 kg. weight per package of meat.

The lack of proper means for shifting load and posture inappropriate during load is one of the factors that should be considered and addressed to correct them. Transportation of cereal bags away from the body to prevent dirty clothes for chewing and chefs is one of the causes of high pressure on employees by this job group. Based on the study by Ataee et al. on the kitchens of the educational hospitals in Qazvin, 93.8% of the workers are responsible for transporting the trawl weighing more than 100 kg, which is not consistent with this study. This is due to the difference in the weight of the load due to the presence of trawls in their study.[17] Also, the average weight of the load transported in the study of Haj Aghazadeh and his colleagues on construction workers was 5 kg, which is incompatible with this study because of the difference in the type of tasks.[30] According to the results of this study, 100% of workers' postures need to be corrected. 35.8% of people must be corrected in the near future. 20.5% of postures should be corrected as soon as possible. The study also found that 43.5% of postures had a very high level of risk and that the worker should restrict from work. Therefore, it is very important to reduce the risk of RULA and consequently to prevent the risk of neck, hands, trunk and feet by postural modification, design workstations, proper posture training for workers, reduction of loaded weight, proper cycle of work, rest in accordance with the work process in each job and task, and performing musculoskeletal examinations to prevent skeletal disorders. Another study by Ms. Rahimi-Moghaddam on workers in the assembly section of one of the Neishabur factories showed that 3.3% of job postures were at the level of priority of corrective actions of 1 and 96.7% on the second level that is incompatible with this study. Also, the study of Kai and Cheng Long in Taiwan in 1998, on construction workers showed more than 30% of the observations had corrective action level 2 (low-risk status) and more than 43.3% of the cases had a physical condition that needs to be corrected as soon as possible or immediately. The results shown in this study are very close to the results of this study, although the types of worker activities differ from those two studies.[32]

According to the analysis of the data on the final scores of the RULA method, the priority ranking of the tasks according to the scores of the final score for the corrective actions was as follows:

The first level (the highest final scores belong to them): carrying pot and heavy materials, rinsing food, cleaning the kitchen.

The second level (the highest final scores after the first level belong to them): bumping, dishwashing, logistics.

The third level (the highest final scores after the second level belong to them): crushing food, grilling.

As the conclusions were drawn, although the logistics task had an average load carrying more than the task of kitchen cleaning. In relation to the task mentioned, the second level was the privilege level, which is the effect of the total score of RULA due to this displacement at division levels. It is recommended to use the wheeled carts to carry out portable boilers, appropriate kitchen layouts, training posters for work, exercise and stretching exercises for static workstations (such as snapping food and taking care of food).

This study is part of a series of studies in the field of kitchen tasks, especially in the context of musculoskeletal problems. Based on this study, inadequate postures and tough work situations, such as carrying loads of high weight are rampant and the problems mentioned are threatening workers of these workplaces.

One of the limitations of this study is not considering the effect of time, temperature and humidity on the posture of individuals, and not calculating the number of musculoskeletal disorders in the tasks of the study. Due to the growing availability of kitchens for party catering, busy people and other people who need ready-made meals and urban kitchens and restaurants, more studies are also necessary on the problems of workers in these workplaces.

Since studies on the evaluation of musculoskeletal disorders in kitchens are very limited, it is suggested that more studies should be done in this field, and for further studies, the association between body mass index, physical work capacity, work history, age, with the prevalence or risk of musculoskeletal disorders, and their impact on the work of the kitchen workers (or kitchens) posters.

Conclusion

The lack of proper means for shifting load and posture inappropriate during load is one of the factors that should be considered and addressed to correct them. Transportation of cereal bags away from the body to prevent dirty clothes for chewing and chefs is one of the causes of high pressure on employees by this job group. According to the results of this study, all workers' postures need to be corrected, and postures had a very high level of risk that workers should be restricted from work. Therefore it is very important to reduce the risk of RULA and consequently prevent the risk of neck, hands, trunk and feet by postural modification, design workstations, proper posture training for workers, reduction of loaded weight, and proper cycle of work and rest, in accordance with the work process in each job and task, performing musculoskeletal examinations to prevent skeletal disorders.

Conflict of interest

The authors declare no conflict of interest.

Acknowledgment

The authors of this article would like to thank the management and all the personnel who helped us with this research.

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