Ergonomic Assessment of Working Posture using Rapid Entire Body Assessment and Quick Exposure Check Methods: A Case Study in Kerman Pottery Workshop

A R T I C L E I N F O

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A B S T R A C T

Aims: One of the important risk factors for MusculoSkeletal Disorders (MSDs) is poor posture at work. The aim of this was to evaluate the posture ergonomics of Kerman potters using Rapid Entire Body Assessment (REBA) and Quick Exposure Check (QEC) methods.

Method and Materials: In this study, detailed evaluations of working postures of the participants were done through photography and filming. To determine the risk levels of the disorders, the workers' physical condition was assessed using the Rapid Entire Body Assessment (REBA) and Quick Exposure Check (QEC) methods. Ergonomic assessment of jobs was done in postures that were either more frequent or the most difficult position of the body in that job.

Findings: According to REBA method, 77.7% of the postures had a moderate risk level which need corrective measures. Moreover, 22.2% of the postures had a high risk level which corrective measures should be taken soon. According to QEC method, 22.2% of the postures were acceptable. About 11.1% of the postures need further study and 66.6% of the postures had a high risk level that need further study and corrective action in the near future.

Conclusion: The results of this study indicate that work postures of studied potters have moderate to high risk and require immediate corrective action to improve working conditions through ergonomic training.

Introduction

MusculoSkeletal Disorders (MSDs) are one of the most common occupational diseases in industrialized and developing countries that cause many disabilities [1]. Ergonomics study the operator's interaction with tools, equipment, the environment, the workplace, work methods and proportions, and other related systems. Damages are work-related if work practices, equipment, equipment handling, or the environment significantly contribute to the causes. Thus, Work-related MusculoSkeletal Disorders (WMSDs) are musculoskeletal injuries at work [2]. Worldwide, problems with symptoms and disorders of the musculoskeletal system are becoming common among the working population [3]. Work-related MusculoSkeletal Disorders includes a wide range of nontraumatic injuries or dysfunctions involving the muscles, tendons, ligaments, nerves, cartilage, intervertebral discs, and joints of the upper extremities, neck, and lower back. These disorders varies from uncontrolled risk factors such as age and gender to changes in biomechanics during different work (activity like lifting, pulling, pushing), physical condition, and psychosocial factors (like thinking, memory, and boredom) [4]. The assessment of biomechanical exposure has emerged as a key issue in developing guidelines to prevent the onset of MSDs in occupational populations and designing appropriate primary prevention interventions that reduce hazardous biomechanical exposure to levels that no

longer harm the workforces [5]. Musculo-Skeletal Disorders have a significant impact on a person's quality of life and can be costly in terms of lost wages and compensation . Posture is one of the most important factors which should be considerd in any posture analysis. Poor, extreme and repetitive postures can increase the risk of MSDs [6].

In 2013, Subhashis Sahu et al used Rapid Entire Body Assessment (REBA) and Rapid Upper Limb Assessment (RULA) methods to assess the body condition of potters and sculptors. There were no significant differences between damage size and study groups. However, there were significant differences in the degree of damage by body part. The analysis showed that different body positions are harmful to people and require ergonomic intervention to improve the quality of life [7]. Vishnu Sasikumar and co-workers conducted a preliminary study using a modified Nordic Questionnaire (NQ) to identify risk in different body parts of computer professionals during work. The dynamic postures involved in the work were assessed using the upper extremity rapid assessment method. Postural, physiological, and load-related factors were considered features of the model. This model was developed using a variety of tested and validated machine learning algorithms. Attitudinal factors of computer experts were significantly related to MSDs. As a result of logistic regression analysis, it was found that physiological factors and work-related factors were also significantly related to MSDs [8]. In a previous study, after identifying workplaces and jobs in furniture factories, Nordic and demographic surveys were used to determine the prevalence and individual characteristics of MSDs respectively. In addition, REBA was used to assess risk factors for MSDs by which high prevalence of MSDs were shown. Working hours are also an important factor in the prevalence of

MSDs. On the other hand, in the assessment of work posture, the type of work and working conditions were also found to be important factors in the prevalence of these disorders [9].

In a previous study, the researchers investigated the working conditions of Gamelan Craft Center operators using rapid ergonomic risk assessment techniques. For a long time, workers worked with slouched, awkward postures and repetitive movements. Performance analysis was performed using three methods: REBA, RULA and Quick Exposure Check (QEC). As a result of the performance ratio analysis, the final score of the three methods was found to be a risk level of 56.25% in REBA, 43.75% in RULA and 62.50% in QEC methods. Therefore, it can be concluded that the three ergonomic risk assessment methods have different proficiency. The QEC method is the best of the three methods for assessing the ergonomic risk of workers in craft centers [10].

An another article using an integrated mathematical programming approach, the effect of five demographic factors on ergonomic risk and occupational injuries was evaluated. The obtained results help managers take the necessary corrective measures or create standards. Two ergonomic risk assessment methods, QEC and REBA, were used to assess MusculoSkeletal Disorders in workers. Demographic variables such as age, height, weight, education and experience have been shown to play an important and effective role in explaining ergonomic risk factors [11]. In another study, the researchers analyzed work ergonomics in the nurseries of a Portuguese municipality with the aim of assessing actual working conditions and employee dissatisfaction. The REBA and QEC were methods used to quantify the risks associated with developing MSDs. Using both methods, 11 tasks were analyzed

and evaluated. There were no statistically significant differences between the results obtained with both methods. However, overestimation was recorded in REBA and QEC in 45% and 25% of cases respectively [12]. In this study, REBA and QEC methods were used to evaluate the physical conditions of workers working in a pottery workshop in Kerman, Iran.

Method and Materials

This study was conducted in one of Kerman's pottery workshops in the year of 2022. The raw materials used in this workshop include talc, feldspar, balckli, kaolin, trans(ceramic: F38, clay: MT60) and silica. On average, in this workshop, 700 pieces are made per day and 500 pieces are glazed standing up per day, and in order to make the slurry, measurements are made in the slurry mixer (blanger) once a week. An average of 30 pieces are carved with tools and needles daily, and this work is done both in standing and sitting position of the workers. In order to assess the physical condition and postural stress of the workers, REBA and QEC methods were used. Moreover, to evaluate the MSDs resulting from working posture, the method of direct observation and photography and filming was used.

The QEC method that is a practical and quick method to evaluate posture and MSDs [13]. Body parts including neck, back, shoulder/arm and hand/wrist could be evaluated by this method [14]. Finally, according to the overall points obtained from each working posture, corrective actions are determined. In this method, according to the observation of the questioner and the answer of the worker, you need comprehensive information the maximum weight of the moving part, the average time to complete the task, the maximum force exerted by one or both hands, driving during the shift, in exposure to vibration while working, speed of work and stressfulness of the job from a psychological point of view are recorded for combining with the scores of 4 areas and determining the score of the whole body. The meaning of further investigation and possible changes

Table 1) The classification of the studied postures with both methods according to the relevant risk level

Rapid Entire Body Assessment (REBA)			
Posture frequency N(%)	**Corrective action**	**Risk Level**	**REBA Score**
0	Unnecessary	Negligible risk	1
0	It may be necessary	Low risk	2-3
77.7	Necessary	Medium risk	4-7
22.3	Soon action	High risk	8-10
-	Necessary and Immediately action	Very high risk	11-15
Quick Exposure Check (QEC)			
Posture percentage	Corrective action	Risk Level	Risk score
22.3	Acceptable	Low risk	<40
11.1	Check more search	Medium risk	41-50
66.6	Check more and make the change soon	High risk	51-70
0	Check more and immediately action	Very high risk	>70

are divided into high risk, which means timely changes and developments, and very high risks, which mean immediate changes and developments. In QEC, evaluation is done quickly, you can do an evaluation for each task within 10 minutes. The inter-observer reliability of this method is acceptable and moderate. The intra-observer reliability in the QEC method is high. In the QEC method, the desired parameters are recorded at one of the moments when the worker is doing the task [15].

The REBA method includes group A (trunk, neck and legs) and group B (upper and lower arms and wrists). Other items include the carried load, grip related to the load and physical effort, each of which is scored separately and finally the final score is calculated for the corresponding posture. From the combination of scores of groups A and B, score C is obtained, then the number of activities is added to the number C and the final score of REBA is obtained, with the help of which the level of ergonomic risk in each of the tasks and the necessity of making corrections are determined. According to the five-class action level related to each score (negligible, low, medium, high and very high), the action level related to the desired posture is selected. The QEC method has 4 action levels and the REBA method has 5 action levels [1].

In order to determine the desired posture for evaluation, tasks were analyzed based on the intensity and duration of work. Small tasks with the worst postures related to performing tasks including measuring grout, moving the barrel under the mixer, making parts, picking and removing containers and parts in the furnace, making grout, designing on containers, designing with glaze and removing the part from the surface. The turntable was selected. After specifying all the desired sub-tasks, the scores of REBA and QEC methods were recorded by direct observation and photography.

Findings

In all 13 workers were evaluated in this study. Table 1 shows the results obtained by the REBA method which 77.7 percent of the postures (N=10) include measuring grout, making parts, making grout, designing on the dish, designing with glaze, removing parts and dishes from the furnace and removing parts from the rotating plate has a moderate level of risk and requires corrective measures. In this regard, about 22.3% of the postures (N=3) while moving the barrel under the mixer and arranging dishes and parts in the oven were in high risk position for which prompt corrective action is required.

Based on the results obtained from the QEC method, about 22.3% of the postures (N=3) were acceptable, 11.1% of the postures (N=1) needed further study and 66.6% of the postures (N=9) were in high risk level and needed further study and corrective action in the near future. The percentage of the studied working postures according to the risk level separation using REBA and QEC methods is shown in Table 2. Accordingly, most of the work postures examined by REBA method were in medium risk level (meaning the need for corrective action) and the majority of work postures examined by the QEC method were in high risk level, meaning further study and corrective action in the near future.

Discussion

The manual nature of pottery work has increased the outbreak of MSDs in this industry. The number of studies conducted in the community of potters is limited, and no study in this industry has used REBA and QEC methods simultaneously to investigate and analyze workers' postures. The analysis of the study reviewed in this research

displayed that the highest prevalence of MSDs in the work environment is observed in the back, neck, shoulder, knee and wrist areas. In a previous study in which the risk factors of MSDs in an aluminum production industry using REBA and QEC methods were evaluated, the authors concluded that the highest prevalence of MSDs occurred in the back, knee and wrist/hand [15] which is consistent with the results of present study. In another study, the working postures of potters and sculptors were evaluated using REBA and RULA methods. The results of this study showed that the most symptoms of MSDs are observed in the back and neck area [7] which are also consistent with the results of our study. In this regard, the studies suggested corrective measures and periodic examinations should be taken into account by the relevant officials as soon as possible for the early detection of these disorders [16]. Although, this study has its own strong points, there is a limitation regarding small sample of workers that were studied. Therefor it is suggested to use a larger statistical sample of workers in future studies. In another study the risk factors for work-related MSDs among welders in the informal sector under resource-constrained conditions using REBA and QEC methods were investigated. Analyses showed a high prevalence of pain in the lower back, right shoulder, left hand wrist and right hand wrist [17] which is similar to the results obtained from present study. Furthermore, MSDs among workers who work with brush cutters in plant maintenance tasks using REBA and QEC methods were evaluated in another study. The results showed that the highest percentage of complaints were present in lumbar spine, feet, dorsal spine, right-wrist/hand, cervical spine and right-thigh [18] which are similar to the present study.

In a study conducted on potters in Maybod city in 2008, the risk factors of MSDs of the upper limbs were identified using the OCRA index method. In this study, the information related to the prevalence of MSDs was collected through the NQ and through interviews, and the OCRA method was used to investigate the risk factors of MSDs. The outcome of the NQ showed that about 59.3% of the potters had MSDs in at least one of their upper limbs in the past year. Moreover, about 34.4% of the potters with wheel-working activity had the highest percentage of MSDs in the upper limbs including wrists, hands and fingers, followed by the shoulders and elbows, which are consistent with the results of present study [16]. .Although this study has its own strength points, but ,maybe, there is some limitation such as error in tools measurements that should be considered in future studies.

Conclusion

The results of this study indicate that work postures of studied potters have moderate to high risk and require immediate corrective action to improve working conditions. The suggestions of this plan include ergonomic training, placing the material bag at a higher height and closer to the waist, using a wheel, increasing the height of the work table and rotating plate, using a chair and doing work while sitting, and using a suitable chair.

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