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Computer-Assisted Ergonomic Analysis of Working Postures Causing Strain

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Abstract

The present study aimed to analyze the postures of workers in a workshop type small-scale furniture manufacturing factory considering seven workstations including edge banding station, horizontal circular saw cutting station, circular saw cutting station, borehole station, planning station, thickness adjustment (planning station, and band saw station. It was also intended to determine the points they have difficulty and what extent they have difficulty (i.e. the level of risk), and to bring the workplace conditions in compliance with the workers' necessities through improvement arrangements about how they can avoid the ergonomic risks and dangers they face. Video recordings and photographs of each process were taken from different angles with cameras. Posture analysis was performed by selecting the movement that is most repetitive, longest, improper and forceful posture. Contrary to the previous studies incorporating estimation-based risk analyses, the present study employs uMED Ergonomics software, which allows analysis by collecting data (i.e. distance and angle) with measurement tools on the image, in analyzing the angles of body parts and clearly revealing the workers' postures. Ergonomic risk analysis was performed using the REBA (Rapid Entire Body Assessment) method, as it numerically quantifies the degree of risk which is one of the effective risk assessment methods. It was determined that the posture modifications and some ergonomic improvements significantly reduced the risk level. Accordingly, once the risk levels were determined (high for Station 1, medium for other stations), the risks were reduced to very low for Stations 4 and 7, and low for other stations.

Keywords: Working postures, ergonomic risk analysis, uMED ergonomics, furniture factory, REBA.

1. Introduction

Although the rapid and intense increase in mechanization together with technological advancements has diversified the physical skills of workers, physical human power is still needed in many industries, and it causes remarkable pressure on employees. Ergonomics is very important to minimize these negative effects or eliminate them (Atasoy et al., 2010). Ergonomics bringing the working and living conditions in compliance with humans by considering the limits of human skills increases the competitive power by increasing the efficiency and effectiveness of work and other activities through increasing productivity and ease of use, as well as decreasing errors. Moreover, certain human values can be achieved by decreasing fatigue and stress, increasing job satisfaction and life standard, and increasing health and safety conditions via prevention of the tasks beyond the human capacity (Helander, 1991; Dizdar et al., 1998; Asensio-Cuesta et al., 2012; Ikonne, 2014).

The main condition for providing an ergonomic environment or product is to make it suitable to the anthropometric size of the individuals who use or benefit from it (Parsons, 2000; Akın and Koca, 2002; Akın and Koca, 2004). Otherwise, employees in working environments, where ergonomic principles are not implemented, have to adapt to those conditions by exhibiting inappropriate working postures (Meenaxi and Sudha, 2012). Minimizing and caring for posture and work is just as important as value of display (Enez and Nalbantoğlu, 2015). In jobs, where human power is used intensely, musculoskeletal system disorders are inevitable in case of unsuitable working conditions (Çiçek et al., 2018). Occupational disorders in the musculoskeletal system are related to physical effort and they are one of the most common health problems worldwide (İçağasıoğlu et al., 2015). Occupational musculoskeletal disorders do not develop suddenly but step by step depending on the recurrence, frequency, and continuity of the erroneous movement (Cohen et al., 1997). These diseases are largely ergonomic deficiencies or incorrect due to working posture (Ünver-Okan and Kaya, 2015). One of the most important research subjects in the discipline of ergonomics is to decrease or prevent the risk for musculoskeletal system disorders (Atasoy Mert, 2014). Musculoskeletal system disorders,

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one of the occupational diseases, remarkably increase in many countries throughout the world. These disorders constitute about 50% of all occupational diseases (Cabeças, 2006). Such disorders significantly increase the loss of workforce because they heal slowly and recur frequently. For instance, lumbar pain recurs by 20-44% in the first year; 60-70% of them recover in 6 weeks and 70-90% of them recover in 12 weeks (Institute for Occupational Safety and Health, 2000). Furthermore, one out of every four employees in Europe complains about back (24.7%) and muscle (22.8%) pains (Parent-Thirion et al., 2007). These problems, which are not given importance in the beginning, and the results they cause remarkably contributed to the increase in studies carried out in ergonomics in the recent period (Sağıroğlu et al., 2015).

Musculoskeletal system disorders such as pain in the neck, lumbar, wrist etc. caused by physical factors such as overload and incorrect postures are widely seen among workers working in industries requiring physical power and effort such as furniture production. It is known that these disorders would be seen more frequently unless the necessary ergonomic arrangements are done. For this reason, it should be noted that simple ergonomic (anthropometric) modifications would positively contribute to workers' health and safety.

Risk assessment is an obligation from the aspect of laws and international standards. Risks related to the work environment and organization are analyzed using the components and applications developed as risk assessment tools. However, these applications fall short regarding the ergonomic risks such as working postures, to which individuals are subjected while working. Since ergonomic risk factors can be easily eliminated by making use of accurate approaches, they come to the forefront from the aspect of protection (Andersen et al., 2002). Ergonomic risk analysis aims to observe the risks in a working environment, determine the risk sources in tasks, which are not in compliance with the ergonomic structure of people, procedures, and activities carried out in businesses, and correct the risky postures that might cause musculoskeletal system disorders (Baş and Yapıcı, 2020).

The methods used in assessing the physical workload are generally classified as measurement-based methods (objective) and observation-oriented methods (subjective) (Li and Buckle, 1999). Because, in this category ergonomic analyzes are carried out using various technical tools such as accelerometers, smart clothing, protractors and electromyography, which provide detailed information about the postures, muscle activities, body movements and strengths of the employees. Within this context, direct laboratory measurement methods that take long time and are costly are not preferred generally. Assessing the infirmary records of companies or the self-reports of employees (diaries of employee, surveys and checklists) is a widely used method since it requires no education other than statistical knowledge (Felekoğlu, 2017). However, systematical observations such as REBA (Rapid Entire Body Assessment), in which the ergonomic risks can be numerically determined, draw attention as highly practical and advanced methods, in which the real conditions can be considered. In the present study using REBA method, ergonomic risk analysis was performed by examining the body parts such as the neck, trunk, and lower and upper extremities in different working postures. This method allows for determining the working postures that might cause occupational musculoskeletal system disorders for the muscle movements created by static, dynamic, and rapidly changing working postures, as well as taking measures against those working postures. REBA method is recommended by Hignett and McAtamney (1998) for easily assessing the risk of musculoskeletal deformations without needing any expensive equipment (Sağıroğlu et al., 2015). The following factors are taken into account in the selection of positions to be evaluated with REBA; most repetitive posture, longest standing, forceful stance, improper posture (Sever and Deste, 2021). The application of the Reba method is as follows, respectively; observation of work, selecting the positions to be evaluated, scoring positions, calculation of REBA score, determination of the risk level (Koç and Testik, 2016).

When the literature is examined, many studies show that REBA method is used. Polat et al., (2017) used the Reba method to analyze the working postures of the workers in the furniture company and to identify risky jobs; they found that 60% of the workers, especially those working on the production and assembly lines, had a high risk level. Kılıç et al., (2018) aimed to evaluate the exposure levels of musculoskeletal system in kitchen furniture (with drawer and door), by using AnyBody Modelling System. It has been reported that the kitchen bottom cupboard with drawers was 45% more ergonomic than the kitchen bottom cupboard with doors. Çiçek et al., (2018) conducted a risk assessment using REBA, OWAS and HMD methods to analyze employee postures in four separate units in a furniture factory. Foaming process has the highest risk score and improvement recommendations were developed for all the operations. Unver-Okan and Kaya (2015) analyzed working postures of 70 women labors working in repikaj works in Trabzon-Of Nursery by REBA method and determined the risk levels. The study results indicate that the risk level score was seven and the women labor who works in repikaj were at moderate risk. They said that the workplace should be arranged ergonomically and workers should be made aware of their working postures.

In this study, it was aimed to determine the risk level and make the necessary improvements by determining the effective working postures for seven different workstations in a furniture workshop where the employee exhibits wrong posture because the necessary ergonomic arrangements are not made.

2. Material and Methods

This study was carried out in a workshop type small-scale furniture manufacturing factory operating in the wood and furniture industry. This facility has been chosen considering the current situation in Turkiye, where workplace type small businesses are dominant. There are seven stations (edge banding station, horizontal circular saw cutting station, circular saw cutting station, borehole station, planning station, thickness adjustment (planning) station, and band saw station) used in wood and furniture production in this workplace. In the present study, in which REBA (Rapid Entire Body Assessment) method was used in determining if the workplace conditions meet the employee capacity for seven workstations, more than 100 posture samples were collected in each station by photos and video recordings of each process from different angles with cameras and among these posture examples, challenging and frequently repeated (most repetitive, longest, forceful, improper) postures were determined. By dividing the body into regions to be coded separately as trunk, neck, leg, upper arm, lower arm, and wrist, the posture position angles of employees were calculated, and the working conditions were analyzed. Thus, by revealing the ergonomic risks and dangers faced by employees due to incorrect working postures, solution suggestions regarding how to avoid those risks were offered and workplace conditions were brought into compliance with employee capacity. In comparison to the eyeball estimations or selections needed in classical survey methods in which the points such as the neck, arm, wrist, body, and leg angles are examined from an ergonomic aspect with the joint angle analyses carried out using the uMED Ergonomy software that can process motion data of obtained from videos and photos clearly revealed the worker postures and a more reliable and clear assessment could be performed. By uploading images to the software, uMED Ergonomics software allows analysis directly on the image or allows analysis by taking measurements (distance and angle) with measurement tools on the image. It also gives information about how much the risk level will change when the working postures are changed with the trials on the program. This situation, allows for effective improvements to be made in the field. In this way, uMED Ergonomics software enables ergonomics analysis of REBA, RULA, NIOSH, OWAS, and QEC.

Using the REBA Method, the body parts are grouped as A (trunk, neck, and leg) and B (upper arm, lower arm, and wrist) first, and then every region is scored for a critical task. Table A and Table B scores obtained from the combinations of body parts are combined with body posture factors, weight of the load, vibration, sudden exposure to the load, and coupling strength scores. Then, the REBA score is calculated by summing the activity intensity score and Table C scores (Figure 1).

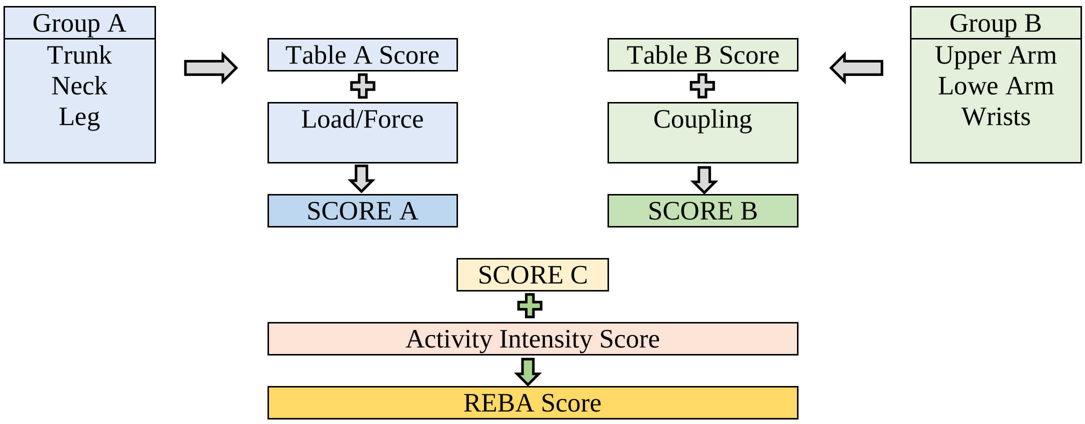

Figure 1. REBA scoring algorithm (Hignett and McAtamney, 2000)

In the REBA method, the final REBA score was achieved using the score calculation tables provided by Hignett and McAtamney (2000) and posture definitions provided by Aygün et al. (2018) (Figures 2-7, Table 1-6). In addition, Tables 7, 8 were used in calculating the weight/load, coupling.

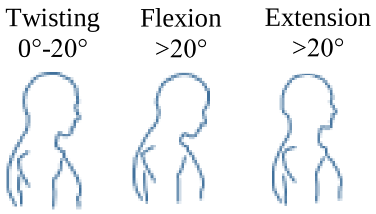

Figure 2. Neck score indicator

Table 1. Neck angle score calculation table

Movement	Score	Change score
0-20°	1	+1 if the neck is twisted +1 if the neck is tilted
>20°	2	
>20°	2	

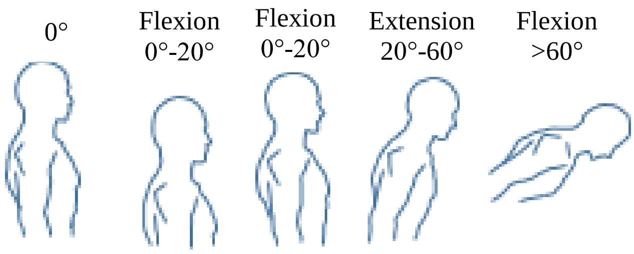

Figure 3. Trunk score indicator

Table 2. Trunk score calculation table

Movement	Score	Change score
0°	1	+1 if the trunk is flexed
0°-20° flexion 0°-20° extension	2	
20°-60° flexion >20° extension	3	+1 if the trunk is tilted
>60° flexion	4	

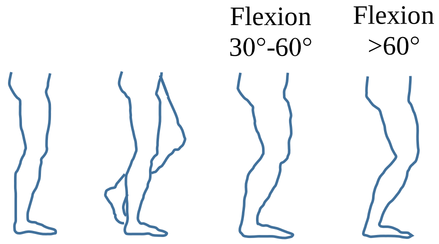

Figure 4. Leg score indicator

Table 3. Leg score calculation table

Movement	Score	Change score
If the load is borne by two legs while sitting or walking	1	+1 in case of knee flexion of 30°-60°
If the load is borne by a single leg or in case of an unbalance posture	2	+1 in case of knee flexion of >60°

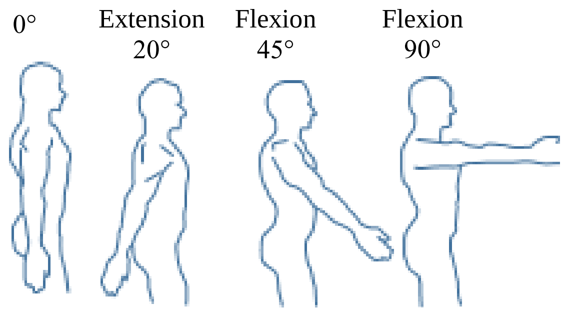

Figure 5. Upper arm score indicator

Table 4. Upper arm score calculation table

Movement	Score	Change score
0°-20° flexion 0°-20° extension	1	+1 in case of working with raised shoulders
20°-45° flexion >20° extension	2	+1 if movement of upper arm is restricted
45°-90° flexion	3	-1 if arms are supported or in case of assisted working
>90° flexion	4	

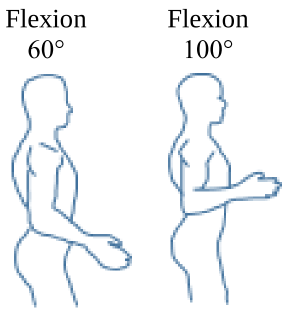

Figure 6. Lower arm score indicator

Table 5. Lower arm score calculation table

Movement	Score
60°-100° flexion	1
<60° flexion >100° flexion	2

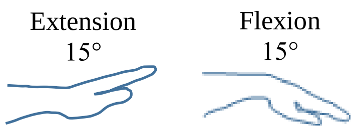

Figure 7. Wrist score indicator

Table 6. Wrist score calculation table

Movement	Score	Change score
0°-15° flexion 0°-15° extension	1	+1 if wrists are twisted to right-left +1 if wrists are tilted
>15° flexion >15° extension	2	

Table 7. Weight-load score calculation table

Movement	Score	Change score
load <5kg	0	
5kg<load <10kg	1	+1 if any shock or rapid carrying of load
load >10kg	2	

Table 8. Coupling score calculation table

Situation	Score
Well-fitting equipment handles and mid-level of coupling strength	0
Hand hold is acceptable but not ideal, supported by another part of the body	1
Hand hold is unacceptable but possible	2
No handle, it is not possible to support holding by hand or body	3

Using Table C, the C score is obtained, which is the combination of A and B scores. The REBA score is obtained by adding the activity intensity score to the C score (Tables 9-10). After calculating the REBA scores, the risk assessments of postures or movements were performed according to Table 11 and the action levels were determined.

Table 9. Calculation of C skore using REBA A and B skore (Hignett and McAtamney, 2000).

		B Skoru											
		1	2	3	4	5	6	7	8	9	10	11	12
A Skoru	1	1	1	1	2	3	3	4	5	6	7	7	7
	2	2	2	2	3	4	4	5	6	6	7	7	8
	3	3	3	3	3	4	5	6	7	7	8	8	8
	4	4	4	4	4	5	6	7	8	8	9	9	9
	5	5	5	5	5	6	7	8	8	9	9	9	9
	6	6	6	6	7	8	8	9	9	10	10	10	10
	7	7	7	7	8	9	9	9	10	10	11	11	11
	8	8	8	8	9	10	10	10	10	10	11	11	11
	9	9	9	9	10	10	10	11	11	11	12	12	12
	10	10	10	10	11	11	11	11	12	12	12	12	12
	11	11	11	11	11	12	12	12	12	12	12	12	12
	12	12	12	12	12	12	12	12	12	12	12	12	12

Table 10. Activity intensity score calculation table

Situation	Score
If one or more organs stay in the same position for longer than 1 minute	1
If one is working for 4 times or more in the same position without walking	1
In case of a rapid change in posture	1

Table 11. REBA Risk Decision Table (Hignett and McAtamney, 2000)

Action Level	REBA Score	Risk Level	Action
0	1	Very Low	Not Necessary
1	2-3	Low	May Be Necessary
2	4-7	Moderate	Necessary
3	8-10	High	Necessary Soon
4	11-15	Very High	Necessary Now

3. Results and Discussion

The workstations used in the present study were (1) edge banding station, (2) horizontal circular saw cutting station, (3) circular saw cutting station, (4) borehole station, (5) planning station, (6) thickness adjustment (planning) station, and (7) band saw station. All the phases from processing the product and production are conducted by the same worker (aged 30 years, height 173 cm, weight 88 kg) having an associate degree and 8 years of experience. The body mass index of the worker was calculated by dividing the weight measured in kg by the square of the height of the body in cm, as specified by the WHO and was 29.4 kg/cm^2. Meters were used to easure height, and weight-scale was used to measure body weight.

The worker has not applied for any healthcare service related to his job and he has not delayed his work. The worker stated that he had neck, arm, and leg pain, especially lumbar and back pains and that he had no training on this subject. Examining more than 100 posture examples from all the workstations, the working postures were analyzed, among these posture examples difficult frequently repeated postures were determined. Thus, the level of risk exposure was determined for each workstation (Table 12).

Table 12. REBA scores and risk levels for all workstations

		Workstations						
		1 Edge Banding	2 Horizontal Circular Saw	3 Circular Saw	4 Bore Drilling	5 Planning	6 Thickness	7 Band Saw
Score A	Neck	3	3	2	2	2	2	2
	Trunk	3	4	4	1	2	3	2
	Leg	2	1	1	1	1	1	1
	Table A	6	3	5	1	3	4	3
	Load/Force	1	0	0	0	0	0	0
		7	3	5	1	3	4	3
Score B	Upper Arm	2	1	3	3	1	2	2
	Lower Arm	2	2	2	2	2	2	2
	Wrist	1	1	1	2	1	2	1
	Table B	2	1	4	5	1	3	2
	Coupling	1	1	1	0	1	1	1
		3	2	5	5	2	4	3
Score C		7	5	6	3	3	4	3
Activity Intensity		1	1	1	1	1	1	1
REBA Score		8	6	7	4	4	5	4
Risk Level		High	Medium	Medium	Medium	Medium	Medium	Medium
Action		Necessary Soon	Necessary	Necessary	Necessary	Necessary	Necessary	Necessary

Examining the working postures in seven workstations, it can be understood that the ergonomic conditions of workers should be improved. It was determined that improvement should be made soon for Station 1 having a high level of risk, whereas the risk level should be reduced via improvements in REBA scores of other workstations having a medium level of risk. Accordingly, making use of REBA scores and risk levels, the accurate working postures were determined for each station by considering the order of priority. Within this context, in order to reduce the risks to acceptable levels, with the working posture trials (by changing the working postures of critical sections) on the uMED Ergonomy software the improvement actions needed for each region and the effects of those improvements on scores were determined in Tables 13-19. Then, the results are presented in Figures 8-14 together with exemplary images. Providing information about which type of basic posture to work with in each station, the presented improvement actions make our preferences easier and, allowing the most appropriate design, they reveal the postures that are suitable for the general structure of the task the most.

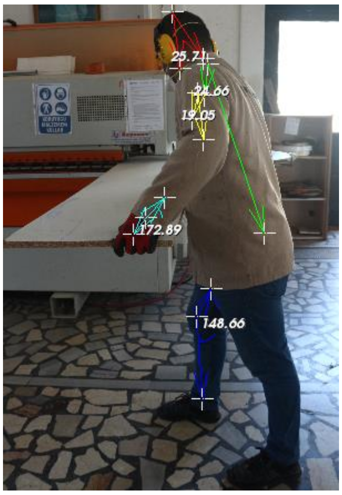

Figure 8. Posture of the worker in Station 1

Table 13. Improvements necessary for Station 1 from the aspect of worker's posture and their effects on the score

Region	Improvement Action	Effect
Neck	Might be adjusted to 0-20° flexion	-1
Neck	Flexion and twist in the neck might be eliminated.	-1
Trunk	Might be adjusted into the upright position.	-3
Trunk	Might be adjusted into 0-20° flexion.	-1
Load	The load might be reduced under 5 kg.	-1
Activity	Frequency of movement might be updated to less than 4 times per minute.	-1

Angle of twist or angle of joint reduces in flexion, whereas angle of extension or angle of joint increases.

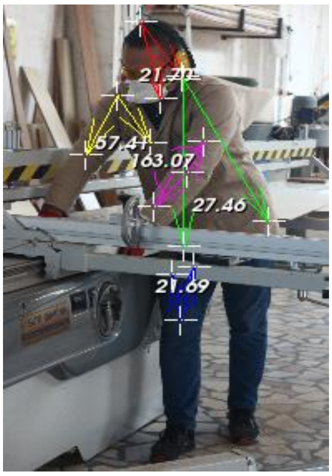

Figure 9. Posture of the worker in Station 2

Table 14. Improvements necessary for Station 2 from the aspect of worker's posture and their effects on the score

Region	Improvement Action	Effect
Neck	Might be adjusted to 0-20° flexion	-1
Trunk	Might be adjusted into the upright position.	-2
Trunk	Might be adjusted to 0-20° flexion	-1
Upper Arm	Might be adjusted to >20° extension.	-1
Upper Arm	Might be adjusted to +/- 20° flexion	-1
Upper Arm	Might be adjusted to 20-45° flexion.	-1
Lower Arm	Elbow flexion might be adjusted to 60-100°.	-1
Coupling	Might be adjusted to the best level.	-1
Activity	Frequency of movement might be updated to less than 4 times per minute	-1

Figure 10. Posture of the worker in Station 3

Table 15. Improvements necessary for Station 3 from the aspect of worker's posture and their effects on the score

Region	Improvement Action	Effect
Neck	Might be adjusted to 0-20° flexion	-1
Trunk	Might be adjusted into the upright position	-2
Trunk	Might be adjusted to 0-20° flexion	-1
Upper Arm	Might be adjusted to >20° extension.	-1
Upper Arm	Might be adjusted to +/- 20° flexion	-1
Upper Arm	Might be adjusted to 20-45° flexion	-1
Upper Arm	Abduction in the arm might be eliminated	-1
Upper Arm	Arm might be supported or person might bend.	-1
Lower Arm	Elbow flexion might be adjusted to 60-100°.	-1
Coupling	Might be adjusted to the best position	-1
Activity	Frequency of movement might be updated to less than 4 times per minute	-1

Angle of twist or angle of joint reduces in flexion, whereas angle of extension or angle of joint increases.

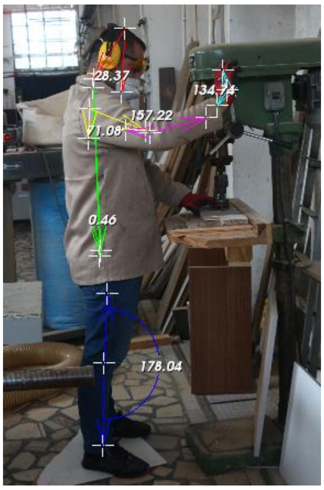

Figure 11. Posture of the worker in Station 4

Table 16. Improvements necessary for Station 4 from the aspect of worker's posture and their effects on the score.

Region	Improvement Action	Effect
Neck	Might be adjusted to 0-20° flexion	-1
Upper Arm	Might be adjusted to +/- 20° flexion	-2
Upper Arm	Might be adjusted to 20-45° flexion	-2
Upper Arm	Might be adjusted to >20° extension.	-2
Lower Arm	Elbow flexion might be adjusted to 60-100°.	-1
Wrist	Hand flexion/extension might be adjusted to <15°.	-1
Activity	Frequency of movement might be updated to less than 4 times per minute	-1

Angle of twist or angle of joint reduces in flexion, whereas angle of extension or angle of joint increases.

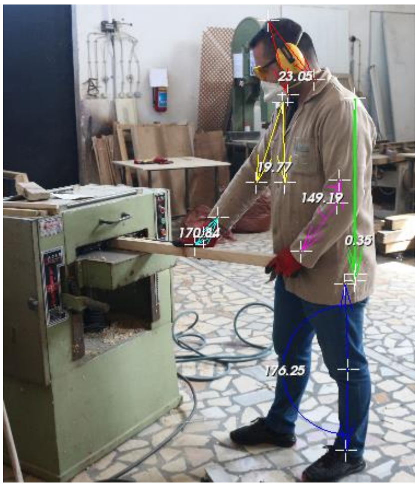

Figure 12. Posture of the worker in Station 5

Table 17. Improvements necessary for Station 5 from the aspect of worker's posture and their effects on the score.

Region	Improvement Action	Effect
Neck	Might be adjusted to 0-20° flexion	-1
Coupling	Might be adjusted to the best position	-1
Activity	Frequency of movement might be updated to less than 4 times per minute	-1

Angle of twist or angle of joint reduces in flexion, whereas angle of extension or angle of joint increases.

Figure 13. Posture of the worker in Station 6

Table 18. Improvements necessary for Station 6 from the aspect of worker's posture and their effects on the score.

Region	Improvement Action	Effect
Neck	Might be adjusted to 0-20° flexion	-1
Trunk	Might be adjusted into the upright position	-2
Trunk	Might be adjusted to 0-20° flexion	-1
Upper Arm	Might be adjusted to +/- 20° flexion	-1
Upper Arm	Arm might be supported or person might bend.	-1
Lower Arm	Elbow flexion might be adjusted to 60-100°.	-1
Wrist	Hand flexion/extension might be adjusted to <15°.	-1
Coupling	Might be adjusted to the good position	-1
Activity	Frequency of movement might be updated to less than 4 times per minute	-1

Angle of twist or angle of joint reduces in flexion, whereas angle of extension or angle of joint increases.

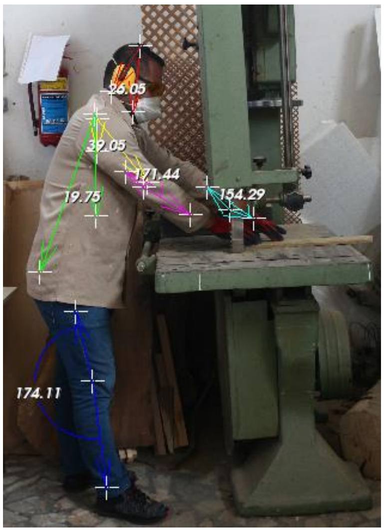

Figure 14. Posture of the worker in Station 7

Table 19. Improvements necessary for Station 7 from the aspect of worker's posture and their effects on the score.

Region	Improvement Action	Effect
Neck	Might be adjusted to 0-20° flexion	-1
Trunk	Might be adjusted into the upright position	-2
Coupling	Might be adjusted to the good position	-1
Activity	Frequency of movement might be updated to less than 4 times per minute	-1

Angle of twist or angle of joint reduces in flexion, whereas angle of extension or angle of joint increases.

After determining the ergonomic dangers and risks, it was projected that the worker would have musculoskeletal system disorders under long-term working conditions. Within the scope of the aforementioned improvement actions and in order to reduce the risks to an acceptable level, the possible improvements were performed considering the working environment and business place conditions, and worker was provided with training about correct working posture and methods. Accordingly, after improvements in risk levels (high for Station 1 and medium for other stations), the risks were reduced to a very low level for Stations 4 and 7 and a low level for other stations (Table 20).

Table 20. REBA scores and risk level changes after necessary improvement actions

Before Improvement Actions							
REBA Score	8	6	7	4	4	5	4
Risk Level	High	Medium	Medium	Medium	Medium	Medium	Medium
After Improvement Actions							
REBA Score	3	2	3	1	2	2	1
Risk Level	Low	Low	Low	Very Low	Low	Low	Very Low

As a result of the assessments, it was determined for Station 1, which requires first-priority improvement action, that the load borne puts weight on the musculoskeletal system and that it had effects on the working posture that was being exhibited. For this reason, necessary preventive measures were taken in order to reduce the effect of the load. In the current working order, single worker lifts the material and moves it on the system. It increases the distance between worker and machine and affects the worker's posture by increasing the load on the musculoskeletal system. It can be stated that, by having the material carried by two people or on a mobile platform, the load on the musculoskeletal system would be minimized and a correct posture could be exhibited. Moreover, carrying by both hands or lifting close to the body would make it easier to lift heavy loads. It is a fact that the risk level will decrease, if such tasks requiring heavy physical work are distributed throughout the day, smaller tasks are put in-between them, and suitable breaks are taken with suitable intervals for resting, then the risk level was reduced. Moreover, since the increasing distance between worker and machine in Stations 3 and 6 led the worker to lean on the table, the reduced risk level suggested that the task should be performed by two persons.

Tissot et al. (2009) reported that back pain was observed more frequently among those standing stationarily (30.4%) and those being able to move on their feet (28.6%) in comparison to those working in a standing position but sometimes sitting (17.4%). Anderson et al. (2007), in their study carried out in 39 business places for two years, determined that back pain was observed 1.9 times more frequently among those working in a standing position for longer than half an hour per hour. However, considering the workstations (seven stations), increasing maximum reach distance in situations requiring lifting and coupling strength might make working in a standing position a more applicable method. Since the muscle movements decrease with static standing, it was determined that, in Stations 3, 4, 6, and 7 which require static working, it was necessary to put foot support in order to reduce the body weight by changing the foot (position). Since the workspace requires walking between stations, resting by walking would reduce the negative effects of working in a standing position.

4. Conclusions

Performing improvements for risk areas, which require regulation, and eliminating all the possible physical, chemical, biological, ergonomic, and psychosocial risks in working environments are among the responsibilities in the field of occupational safety and health. It can be seen that the measures taken by many employers in order to prevent occupational accidents do not include ergonomic adjustments and there is no consciousness regarding this subject (Tol, 2019). Considering the regulations implemented in business places and examining the regulation and workplace practices, ergonomics is given a secondary importance or not known enough (Çiçek and Çağdaş, 2020). In the present study, by analyzing the working postures, the musculoskeletal system risks were examined using the REBA method. Then, the actions to be taken in order to adjust workplace conditions to be suitable for worker capacity are presented together with their effect levels.

In Stations 4 (bore holing machine) and Station 7 (band saw) having limited reach distance, it is recommended to work in a standing position by occasionally sitting. In order to reduce the repetitive movements, the number of repeats should be adjusted (limited) to less than 4 times per minute in all the stations or, if it is difficult to limit it, to exchange tasks between workers.

Researchers corroborated that the best design was the upper level of bench lower than the elbow of worker and, if possible, all the working surfaces should be arranged for the exact person working there (Koçak, 2007). The working postures observed in the present study force the workers to lean on the table surface. Especially when working long hours, it is necessary to re-design the machines by adding adjustable-height machine bases in order to prevent possible shoulder and back disorders.

Besides occupational accidents and occupational diseases, undesired results of ergonomic problems also reduce the quality of life of workers even after an active working life and cause chronic health problems limiting their daily activities (Engür and Chaush-Ogly, 2019). Pandey and Aditi (2013) concluded that special training, which might minimize the ergonomic risk factors in a workplace, would improve the health conditions and increase the productivity of workers. For this reason, periodical training programs should be organized in order to prevent musculoskeletal system disorders among workers and emphasize the importance of resting and pauses during working hours (Dsingh and Kaur 2019). It should be noted that awareness activities incorporating visual instruments such as posters and training sessions, in which accurate working postures and methods are taught, would have protective effects in preventing musculoskeletal system disorders. Within this context, ergonomic risk assessment should be performed in further detail during the risk assessments performed within the scope of the Occupational Health and Safety Risk Assessment Regulation (Koç and Testik, 2016). In addition, a system allowing workers to provide self-reports about disorders should be established. Pressure on the musculoskeletal system should be decreased via suitable exercises to be encouraged and health controls should be performed on regular basis.

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