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Investigation of The Posture Positions of The Apparel Workshop Employees with The Rapid Entire Body Assessment(REBA) and Rapid Upper Limb Assessment(RULA) Method

Senol Yavuz[1] Berna Gur[1] Ahmet Dogan Cakir[1] Dursun Ali KOSE[2]
[1]Hitit University, Department of Property Protection and Security, Corum, Turkey
[2]Hitit University, Department of Chemistry, Corum, Turkey

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***Correspondence to**: Senol Yavuz, Hitit University, Property Protection and Security, 19500, Corum, TURKEY*
E-Mail: senolyavuz@hitit.edu.tr

ABSTRACT

As the industry made progress, human labor force gained importance as an element of work life. The science of ergonomics came into being in order to take necessary precautions by determining the convenience of human motions with anatomy and risks and possible dangers during work. Through the methods of risk assessment, risks and possible dangers are determined to create a healthy environment for workers. Through REBA and RULA risk assessment methods, worker motions and postures are studied to determine convenience by calculating risk scores related to worker motions. The aim of REBA and RULA risk assessment methods is to study whether or not the worker is functioning in accordance with his/her skills and to prevent labor accidents and occupational diseases as a result of the data obtained. In this study, REBA and RULA risk scores are tried to be calculated by studying the motions of apparel workshop employees working in the fabric cutting, quality, packaging, ironing and stain removal sections. According to the analysis obtained, REBA score for the fabric cutting employee is 6, RULA score for the sewing machine operator is 4, REBA score for the quality control employee is 4, REBA score for the stain removal employee is 3, REBA score for the ironing employee is 6 and REBA score for the packaging employee is 5. According to the scores obtained through the use of REBA and RULA risk assessment method, the motions and postures of employees are determined to be at dangerous levels. The results obtained by examining the postures of the employees according to the REBA and RULA risk tables, and the results confirming the hazard class of the workplace show that it can be used in ergonomic risk analysis.Among the primary precautions needed to be taken to prevent the risks can be having the employee work at different tasks within certain intervals, monitoring the health, providing occupational health and safety educational programs.

Keywords:
Ergonomics, REBA, Risk assessment, RULA.

INTRODUCTION

The human labor force gained importance with the industrial revolution. At first, there was barely any study on occupational accidents and diseases. As the time went on, the term "occupational health and safety" gained importance primarily in England and later on in other European countries with "providing the workers a healthy and safe environment" in mind as occupational health issues rose and accidents began happening due to the nature of the work. In time, the Occupational Health and Safety legislation (numbered 6331) has been implemented so as to prevent occupational accidents and diseases[1].

Thanks to the technology on the rise, employees' activities in the workplace has been studied with the Occupational Health and Safety applications. Determining the dangers and risks by studying employees' activities and working environments led to the development of proactive approaches. Employees have been raising their awareness with the help of risk assessment methods, environment observations and occupational health and safety education programmes[2,3].

The Occupational Health and Safety legislation (numbered 6331) imposes the employer to conduct risk

assessment or have it done. The main aim of risk assessment is to take precautions by determining the risks and dangers at the work place providing the workers with a safe environment to work at. Proactive approach is the efforts made before the occupational accidents or disease comes to happen[3].

Prolonged working hours, faulty postures, non-ergonomic weight lifting motions and repetitive motions causing physical and mental fatigue are all known to cause occupational diseases[4,5]. It's crucial to study employees' structural and psychological properties. Human muscle and skeletal system is capable of some certain movement power and skills, detecting the environment and defending itself when needed. That's why there must be a harmony between an employee's motions and his/her basic characteristics[6].

Ergonomics studies the compatibility of the job with the worker but not the compatibility of the worker with the job. Additionally, it takes the physical properties of the worker into account. The term "ergonomics" is comprised of two counterparts : "ergo" which means "labor" and "nomos" meaning "law"[7]. It was first used in England in 1949[8,9].

Arranging the working environment ergonomically, leads to employees' being protected against occupational risks and encourages productivity thus leading the establishment to make more profit[10]. "Human-tools and equipment-working environment" harmony is known to be of a great importance. Whereas certain educational programmes have been implemented by some companies in order to promote employees' compliances with tools and equipment and working environment, some physical rearrangements in the workplace are also put into action[11]. Environmental and physical risks present in the workplace and employees' postures and repetitive movements may result in muscular and skeletal impairments[12]. According to the data supplied by the Social Security Institution, muscular and skeletal system diseases make up 7,5% of the occupational diseases[13]. According to the statistics, besides the occupational accidents, it's clear that occupational diseases are important, as well. Unless the necessary precautions are taken, the rate of muscular and skeletal diseases will eventually rise[13].

The most important way to prevent muscular and skeletal diseases by foreseeing the ergonomical dangers is to implement the risk assessment enabling to determine such dangers. As the ergonomical risk assessment is properly implemented in instituons and corporations, the dangers and as well as the ergonomical risks that the employees and the employers can possibly be facing could be foreseen effectively[14].

Rapid Entire Body Assessment (REBA) and Rapid Upper Limb Assessment (RULA) in Ergonomical Risk Analysis

Today, one of the most common occupational health diseases is muscular and skeletal diseases. 29% of loss in the quality and productivity in a workplace stems from muscular and skeletal diseases [15]. The physical labor burden analysis is done to show the faulty posture effects employees' health negatively. The muscular and skeletal diseases caused by the faulty posture is closely related to the environmental conditions, frequency of the work and the amount of the weights lifted [16]. Various methods have been developed to determine the risk of such factors turning into a cause of health issue in people. These methods are grouped as three. They are namely as;

- Personal Survey Method,
- Methods Based on Systematic Observations,
- Direct Measurement Method

Systematic Methods are also divided into two as Basic and Advanced Observations. Basic observations utilize methods like RULA(Rapid Upper Limb Assessment), REBA(Rapid Entire Body Assessment), NIOSH(Lifting Equation Calculator), ROSA((Rapid Office Strain Assessment) etc. while advanced observations utilize methods like Ergo-Man, 3DSSPP, Jack, RAMSIS Modelling etc[17].

REBA method is used to determine the amount of risk a posture or a movement poses. The torso, neck, legs, arms (lower and upper) in a certain position and twists in wrists,

Table 1. RULA and REBA score and risk groups [20].

Rula		*Reba*	
Score	*Risk*	*Score*	*Risk*
1-2	*Acceptable*	*1*	*Insignificant risk*
3-4	*Detailed inspection, may need changes*	*2-3*	*Low risk, may need changes*
5-6	*Detailed inspection, immediate change*	*4-7*	*Medium risk, detailed inspection, immediate change*
7	*Re-evaluation, application change*	*8-10*	*High risk, re-evaluation, application change*
		>11	*Very high risk, application change*

relativity of twist effects to the amount of load are expressed through numeric values varying from 1 to15[18]. As determining the numeric values (scores), the body is divided into two groups: Group A, which is made up of torso, neck and legs and Group B, which is made up of upper arms, lower arms and wrists. Scores resulted from Group A wascombined the Score A. The final Score A is derived by adding the force/load score. The posture scores in Group B were determined and combine the Score B. Scores A and B are added up to derive Score C. The risk levels of posture positions and related risk priorities are determined with help of data. RULA method is somewhat similar to REBA. In the RULA method, feet positioning and work-limb match and activities in addition to the areas studied in REBA method are all taken into account to derive a score. In REBA and RULA methods, the risk level is determined in accordance with the score intervals [19].

MATERIALS AND METHODS

In the apparel production workshops, from fabric cutting to packaging, 6 different tasks employing fabric cutters, machine operators, quality controllers, stain removers, ironers and packer-ups have been analyzed in ergonomic risk perspective by the use of REBA and RULA methods regarding 2 types of postures. REBA method have been utilized for tasks such as fabric cutting, quality control, stain removal, ironing and packaging whereas RULA method have been preferred for tasks carried out in sitting position such as machine sewing [25].

The Task of Fabric Cutting by Using Fabric Cutting Saw

In Fig. 1 body angles of the worker were estimated by using Angle Meter software and the analysis results by the REBA method are presented on Table 1.

The neck and the body of the worker aligned on a straight angle varying from 0° to 20° and because of the lack of neck turns, bending and stretching movements, risk score of the neck has been considered as 1. Torso lean of the worker was estimated approximately 46° and because the value falls within the 20° – 60° interval and due to the lack of turning and bending movements, risk score of the torso has been considered as 3.

Risk score has been considered as 1 in the evaluation of the feet, since the worker's both feet stepped on the ground. As these values were calculated on the REBA Score A table, the risk score has been detected as 2. The approximate angle of the upper arm of the worker was estimated as 97°. Since the value is greater than 90°, the risk score has been estimated as 4. The angle of the lower arm was approximately estimated as 37o and since the value is below 60° the risk score has been estimated as 2.

The wrist angle was considered as 0 for it works on a straight position. The risk score has been estimated as 1 since the angle is below 15°. As these values were calculated on the REBA Score B table, the risk score has been estimated as 5. As the REBA A and B scores were co-calculated on the REBA Score C table, the outcome has become risk score of 4.Adding 2 more scores -one of which has been added as an additional 1 score due to the body parts immobilized for more than a minute whereas the other 1 score has been added due to movements repeated for 4 times or more in a minute without walking – a total of REBA Risk Score of 6 has been calculated. That figure corresponds with a "medium risk and requires precautions" level on REBA Risk Evaluation Table.

The Task of Sewing by Using a Sewing Machine

The body angles of the worker seen in the Fig. 2 were approximately measured using Angle Meter software and RULA method was utilized since the worker worked in seated position and the analysis results are presented in Table 2. The upper arm angle measured at 60°. This angle is considered within 45° – 60° interval and the risk score has been measured as 3. Rise in shoulder's position, stretch in arms and restricted upper arm movements wasn't detected. However, judging from the fact that the arms were supported by the counter, the risk score has been reduced by 1 point and the revised risk score has been estimated as 2. The worker's lower arm's working position was estimated as 108°. As this value is greater than 100° on the calculation table, the risk score has been estimated as 2.As the wrist angle was considered lower

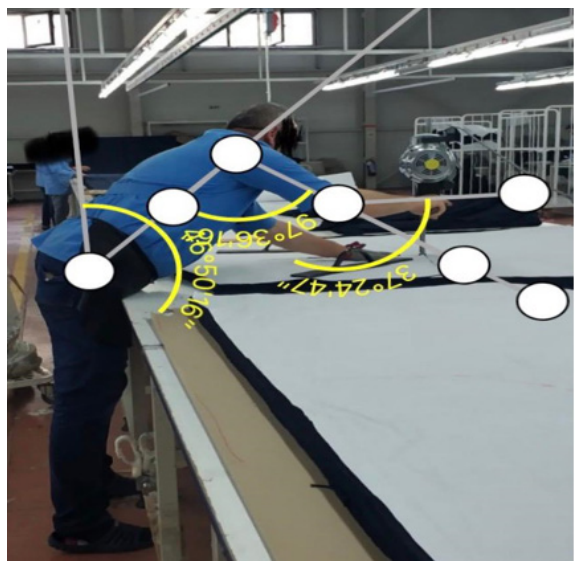

Figure 1. The task of fabric cutting.

Table 2. REBA analysis of fabric cutting task.

Table 2a. Posture A score.

Posture A Score = 2		Neck											
		1				2				3			
Legs		1	2	3	4	1	2	3	4	1	2	3	4
Torso	1	1	2	3	4	1	2	3	5	3	3	5	6
	2	2	3	4	5	3	4	5	6	4	5	6	7
	3	2	4	5	6	4	5	6	7	5	6	7	8
	4	3	5	6	7	5	6	7	8	6	7	8	9
	5	4	6	7	8	6	7	8	9	7	8	9	9

Table 2b. Posture B score.

Posture B Score= 5		Lower arm					
		1			2		
Upper arm	Wrist	1	2	3	1	2	3
	1	1	2	2	1	2	3
	2	1	2	3	2	3	4
	3	3	4	5	4	5	5
	4	4	5	5	5	6	7
	5	6	7	8	7	8	8
	6	7	8	8	8	9	9

Table 2c. Total score.

Total C Score= 4		Posture B Score											
		1	2	3	4	5	6	7	8	9	10	11	12
Posture A Score	1	1	1	1	2	3	3	4	5	6	7	7	7
	2	1	2	2	3	4	4	5	6	6	7	7	8
	3	2	3	3	3	4	5	6	7	7	8	8	8
	4	3	4	4	4	5	6	7	8	8	9	9	9
	5	4	4	4	5	6	7	8	8	9	9	9	9
	6	6	6	6	7	8	8	8	8	10	10	10	10
	7	7	7	7	8	9	9	9	10	10	11	11	11
	8	8	8	8	8	9	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	11	12	12	12	12	12	12	12
	12	12	12	12	12	12	12	12	12	12	12	12	12
Activite Score 2													
REBA Risk Score = 6													

than 15°, the risk score has been considered as 2 according to the calculation table. The wrist twist angle was also considered lower than 15° and risk score has been considered as 1 according to the calculation table. As the values obtained were evaluated on the RULA A Score Table, the risk score has been estimated as 3.

The worker's neck angle was measured approximately as 36°. Since this value is greater than 20° according to the calculation table, the risk score has been considered as 2. Because there weren't any stretching or rotating motions on the neck, no others score has been added. Torso lean was approximately estimated as 23° and since this value falls within 20° – 40° interval, the risk score has been considered as 3. No other score has been added due to lack of rotating or leaning sideways motion on the torso.

Figure 2. The task of sewing.

Table 3. RULA analysis for fabric sewing.

Table 3a. Posture A score.

Posture A Score = 3			Wrist							
			1		2		3		4	
			Wrist Twist							
		Lower Arm	1	2	1	2	1	2	1	2
Upper Arm For Supporting Arms, it gets -1 Point. For this reason, The upper Arm Score is evaluated as 3-1 = 2 Point. ÜST KOL	1	1	1	2	2	2	2	3	3	3
		2	2	2	2	2	3	3	3	3
		3	2	3	3	3	3	3	4	4
	2	1	2	3	3	3	3	4	4	4
		2	3	3	3	3	3	4	4	4
		3	3	4	4	4	4	4	5	5
	3	1	3	3	4	4	4	4	5	5
		2	3	4	4	4	4	4	5	5
		3	4	4	4	4	4	5	5	5
	4	1	4	4	4	4	4	5	5	5
		2	4	4	4	4	4	5	5	5
		3	4	4	4	5	5	5	6	6
	5	1	5	5	5	5	5	6	6	7
		2	5	6	6	6	6	7	7	7
		3	6	6	6	7	7	7	7	8
	6	1	7	7	7	7	7	8	8	9
		2	8	8	8	8	8	9	9	9
		3	9	9	9	9	9	9	9	9

Table 3b. Posture B score.

Posture B Score = 4		Torso											
		1		2		3		4		5		6	
Legs		1	2	1	2	1	2	1	2	1	2	1	2
Neck	1	1	3	2	3	3	4	5	5	6	6	7	7
	2	2	3	2	3	4	5	5	5	6	7	7	7
	3	3	3	3	4	4	5	5	6	6	7	7	7
	4	5	5	5	6	6	7	7	7	7	7	8	8
	5	7	7	7	7	7	8	8	8	8	8	8	8
	6	8	8	8	8	8	8	8	9	9	9	9	9

Table 3c. Total score.

C Total Score = 4		RULA B Score						
		1	2	3	4	5	6	7+
RULA A score	1	1	2	3	3	4	5	5
	2	2	2	3	4	4	5	6
	3	3	3	3	4	4	5	6
	4	3	3	3	4	5	6	6
	5	4	4	4	5	6	7	7
	6	4	4	5	6	6	7	7
	7	5	5	6	6	7	7	7
	8	5	5	6	7	7	7	7

Lastly, the task was carried out in sitting position with the legs supported thus scoring 1 regarding the risk score for the legs. As the risk scores obtained was evaluated on the RULA B Score table, the risk score has been measured as 4 points. As the RULA A and B scores have been placed on the RULA C Score table, the risk score measures at 4 points. That value (Fig. 2) corresponds with "the may need changes" risk level on RULA Risk Evaluation Table.

The Task of Product Quality Control

The position we will see in Fig. 3 contains the worker doing the quality control task whose certain bodily angles were approximately measured by Angle Meter software and the analysis results by REBA method have been presented in Table 3.

Table 4. REBA analysis for the product quality control task.

Table 4a. Posture A score.

Posture A Score = 2		Neck											
		1				2				3			
Legs		1	2	3	4	1	2	3	4	1	2	3	4
Torso	1	1	2	3	4	1	2	3	5	3	3	5	6
	2	2	3	4	5	3	4	5	6	4	5	6	7
	3	2	4	5	6	4	5	6	7	5	6	7	8
	4	3	5	6	7	5	6	7	8	6	7	8	9
	5	4	6	7	8	6	7	8	9	7	8	9	9

Table 4b. Posture B score.

Posture B Score = 3		Lower arm					
		1			2		
Upper arm	Wrist	1	2	3	1	2	3
	1	1	2	2	1	2	3
	2	1	2	3	2	3	4
	3	3	4	5	4	5	5
	4	4	5	5	5	6	7
	5	6	7	8	7	8	8
	6	7	8	8	8	9	9

Table 4c. Total score.

Total C Score= 2		Posture B Score											
		1	2	3	4	5	6	7	8	9	10	11	12
Posture A Score	1	1	1	1	2	3	3	4	5	6	7	7	7
	2	1	2	2	3	4	4	5	6	6	7	7	8
	3	2	3	3	3	4	5	6	7	7	8	8	8
	4	3	4	4	4	5	6	7	8	8	9	9	9
	5	4	4	4	5	6	7	8	8	9	9	9	9
	6	6	6	6	7	8	8	8	8	10	10	10	10
	7	7	7	7	8	9	9	9	10	10	11	11	11
	8	8	8	8	8	9	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	11	12	12	12	12	12	12	12
	12	12	12	12	12	12	12	12	12	12	12	12	12
Activite Score 2													
REBA Risk Score = 4													

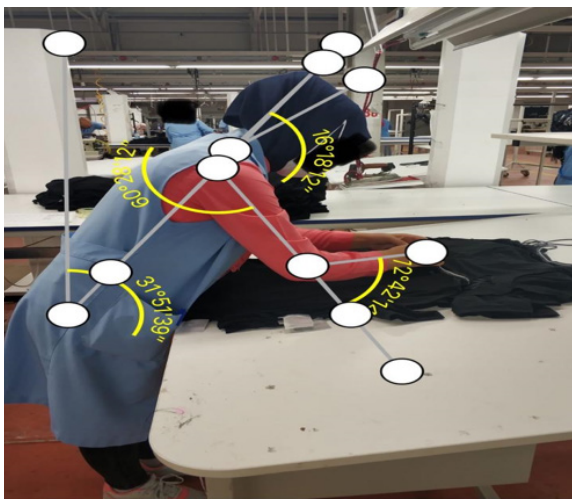

Figure 3. The task of product quality control.

The worker's neck angled at around 16° and the neck risk score has been calculated as 1. The worker's torso angle was around 31° and the risk score has been calculated as 3 according to the table of calculation. For the worker stood on both her feet, the risk score has been calculated as 1. As these values have been calculated on REBA A Score table, the risk score has been estimated as 2.

The worker's upper arm angle was approximately at 60° and since this value falls within 45° – 90° interval, the risk score has been calculated as 3. As the lower arm angle was calculated 72°, the risk score coherent with the calculation table has been estimated as 1.Because the wrist working angle was less than 15°, the risk score has been estimated as 1. As these values were evaluated on the REBA B Score table, risk score has been estimated as 2.

Table 5. REBA analysis for stain removal task.

Table 5a. Posture A score.

Posture A Score = 1		Neck											
		1				2				3			
Legs		1	2	3	4	1	2	3	4	1	2	3	4
Torso	1	1	2	3	4	1	2	3	5	3	3	5	6
	2	2	3	4	5	3	4	5	6	4	5	6	7
	3	2	4	5	6	4	5	6	7	5	6	7	8
	4	3	5	6	7	5	6	7	8	6	7	8	9
	5	4	6	7	8	6	7	8	9	7	8	9	9

Table 5b. Posture B score.

Posture B Score = 1		Lower arm					
		1			2		
Upper arm	Wrist	1	2	3	1	2	3
	1	1	2	2	1	2	3
	2	1	2	3	2	3	4
	3	3	4	5	4	5	5
	4	4	5	5	5	6	7
	5	6	7	8	7	8	8
	6	7	8	8	8	9	9

Table 5c. Total score.

Total C Score= 1		Posture B Score											
		1	2	3	4	5	6	7	8	9	10	11	12
Posture A Score	1	1	1	1	2	3	3	4	5	6	7	7	7
	2	1	2	2	3	4	4	5	6	6	7	7	8
	3	2	3	3	3	4	5	6	7	7	8	8	8
	4	3	4	4	4	5	6	7	8	8	9	9	9
	5	4	4	4	5	6	7	8	8	9	9	9	9
	6	6	6	6	7	8	8	8	8	10	10	10	10
	7	7	7	7	8	9	9	9	10	10	11	11	11
	8	8	8	8	8	9	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	11	12	12	12	12	12	12	12
	12	12	12	12	12	12	12	12	12	12	12	12	12
Activite Score 2													
REBA Risk Score = 3													

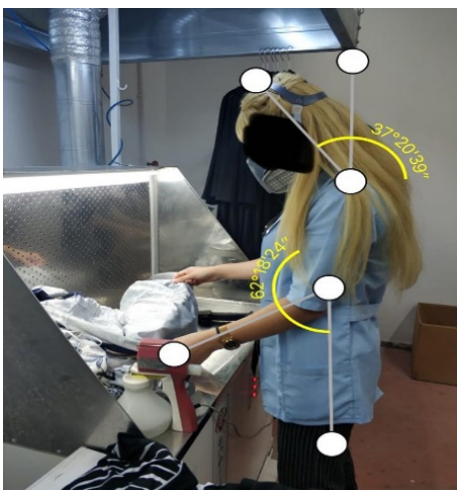

Figure 4. The task of stain removal.

Adding 2 more scores -one of which has been added as an additional 1 score due to the body parts immobilized for more than a minute or use of more than one body parts whereas the other 1 score has been added due to movements repeated for 4 times or more in a minute without walking – a total of REBA Risk Score of 4 has been calculated. That figure corresponds with a "medium risk and requires precautions" level on REBA Risk Evaluation Table.

The Task of Stain Removal

The position we will see in Fig.4 contains the worker doing the stain removal task whose certain bodily angles were approximately measured by Angle Meter software and the analysis results by REBA method have been presented in Table 4.

Table 6. REBA analysis for the task of product ironing.

Table 6a. Posture A score.

Posture A Score = 2		Neck											
		1				2				3			
Legs		1	2	3	4	1	2	3	4	1	2	3	4
Torso	1	1	2	3	4	1	2	3	5	3	3	5	6
	2	2	3	4	5	3	4	5	6	4	5	6	7
	3	2	4	5	6	4	5	6	7	5	6	7	8
	4	3	5	6	7	5	6	7	8	6	7	8	9
	5	4	6	7	8	6	7	8	9	7	8	9	9

Table 6b. Posture B score.

Posture B Score = 1		Lower arm					
		1			2		
Wrist		1	2	3	1	2	3
Upper arm	1	1	2	2	1	2	3
	2	1	2	3	2	3	4
	3	3	4	5	4	5	5
	4	4	5	5	5	6	7
	5	6	7	8	7	8	8
	6	7	8	8	8	9	9

Table 6c. Total score.

Total C Score= 4		Posture B Score											
		1	2	3	4	5	6	7	8	9	10	11	12
Posture A Score	1	1	1	1	2	3	3	4	5	6	7	7	7
	2	1	2	2	3	4	4	5	6	6	7	7	8
	3	2	3	3	3	4	5	6	7	7	8	8	8
	4	3	4	4	4	5	6	7	8	8	9	9	9
	5	4	4	4	5	6	7	8	8	9	9	9	9
	6	6	6	6	7	8	8	8	8	10	10	10	10
	7	7	7	7	8	9	9	9	10	10	11	11	11
	8	8	8	8	8	9	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	11	12	12	12	12	12	12	12
	12	12	12	12	12	12	12	12	12	12	12	12	12
Activite Score 2													
REBA Risk Score = 6													

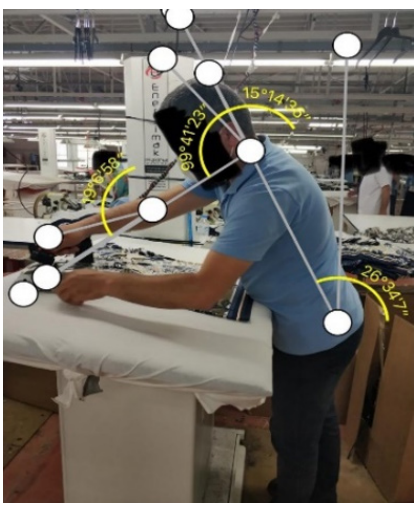

Figure 5. The task of product ironing.

The worker's neck angled at around 37° and since this value is greater than 20°, the risk score for the neck was calculated as 2°. The worker carried out the task on a straight posture and that's why the risk score was calculated as 1.For the worker stood on both her feet, the risk score was calculated as 1. As these values was calculated on REBA A Score table, the risk score was estimated as 1. Since the upper arm angle of the worker was evaluated within the 0° -20°interval, it was calculated as 1 risk score according to the calculation table.

For the worker's lower arm angle was calculated as 62°, the risk score on the table has been estimated as 1. Because the wrist working angle was less than 15°, the risk score has been calculated as 1. As these values were calculated on REBA B score table, the risk score has been estimated as 1. As REBA A and REBA B scores have been placed on

Table 7. REBA analysis for product packaging.

Table 7a. Posture A score.

Posture A Score = 2		Neck											
		1				2				3			
Legs		1	2	3	4	1	2	3	4	1	2	3	4
Torso	1	1	2	3	4	1	2	3	4	1	2	3	4
	2	1	2	3	4	1	2	3	5	3	3	5	6
	3	2	3	4	5	3	4	5	6	4	5	6	7
	4	2	4	5	6	4	5	6	7	5	6	7	8
	5	3	5	6	7	5	6	7	8	6	7	8	9

Table 7b. Posture B score.

Posture B Score = 1		Lower arm					
		1			2		
Wrist		1	2	3	1	2	3
Upper arm	1	1	2	2	1	2	3
	2	1	2	3	2	3	4
	3	3	4	5	4	5	5
	4	4	5	5	5	6	7
	5	6	7	8	7	8	8
	6	7	8	8	8	9	9

Table 7c. Total score.

Total C Score= 4		Posture B Score											
		1	2	3	4	5	6	7	8	9	10	11	12
Posture A Score	1	1	1	1	2	3	3	4	5	6	7	7	7
	2	1	2	2	3	4	4	5	6	6	7	7	8
	3	2	3	3	3	4	5	6	7	7	8	8	8
	4	3	4	4	4	5	6	7	8	8	9	9	9
	5	4	4	4	5	6	7	8	8	9	9	9	9
	6	6	6	6	7	8	8	8	8	10	10	10	10
	7	7	7	7	8	9	9	9	10	10	11	11	11
	8	8	8	8	8	9	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	11	12	12	12	12	12	12	12
	12	12	12	12	12	12	12	12	12	12	12	12	12
Activite Score 2													
REBA Risk Score = 5													

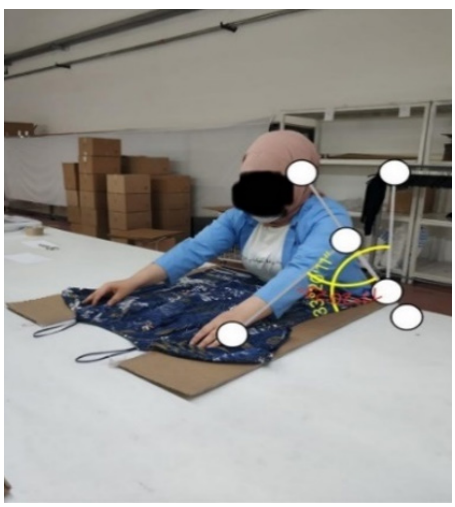

Figure 6. The task of product ironing.

the REBA C score table, the risk score has been estimated as 1.Adding 2 more scores -one of which has been added as an additional 1 score due to the body parts immobilized for more than a minute or use of more than one body parts whereas the other 1 score has been added due to movements repeated for 4 times or more in a minute without walking – a total of REBA Risk Score of 3 has been calculated. That figure corresponds with a "low risk and may require precautions" level on REBA Risk Evaluation Table.

The Task Of Product Ironing

The position we will see in Fig.5 contains the worker doing the product ironing task whose certain bodily angles were approximately measured by Angle Meter software and the analysis results by REBA method have been presented in Table 5.The worker's neck angled at around 15°

and since this value is lower than 20°, the risk score for the neck was calculated as 1°.

The worker's torso angle was around 26° and since this value falls within 20° - 60° interval,the torso risk score has been calculated as 3 . For the worker stood on both her feet, the risk score has been calculated as 1. As these values have been calculated on REBA A Score table, the risk score has been estimated as 2. For the worker's upper arm angle was approximately calculated as 99° and because this value was greater than 90°, the risk score has been calculated as 4.

For the worker's lower arm angle was calculated as 20°, the risk score on the table has been estimated as 2. Because the wrist working angle was less than 15°, the risk score has been calculated as 1. As these values were calculated on REBA B score table, the risk score has been estimated as 5.As REBA A and REBA B scores have been placed on the REBA C score table, the risk score has been estimated as 4.

Adding 2 more scores -one of which has been added as an additional 1 score due to the body parts immobilized for more than a minute or use of more than one body parts whereas the other 1 score has been added due to movements repeated for 4 times or more in a minute without walking – a total of REBA Risk Score of 6 has been calculated. That figure corresponds with a "medium risk and requires precautions" level on REBA Risk Evaluation Table.

The Task of Product Packaging

The position we will see in Fig. 6 contains the worker folding the product for packaging task whose certain bodily angles were approximately measured by Angle Meter software and the analysis results by REBA method have been presented in Table 6.The worker's neck angled at around 0° – 20° interval and the risk score has been calculated as 1 according to the table.The worker's torso angle was calculated as around 33° and since this value falls within 20° - 60° interval, the torso risk score has been calculated as 3.For the worker stood on both her feet, the risk score has been calculated as 1.

As these values have been calculated on REBA A Score table, the risk score has been estimated as 2. For the worker's upper arm angle was approximately calculated as 77° and because this value falls within 45°-90° interval, the risk score has been calculated as 3 according to the calculation table. As the lower arm angle was calculated lower than 60°, the risk score has been considered as 2 according to the calculation table. Because the wrist working angle was less than 15o, the risk score has been estimated as 1. As these values were evaluated on the REBA B Score table, risk score has been estimated as 4. As REBA A and REBA B scores values have been placed on the REBA C score table, the risk score has been estimated as 3.

Adding 2 more scores -one of which has been added as an additional 1 score due to the body parts immobilized for more than a minute or use of more than one body parts whereas the other 1 score has been added due to movements repeated for 4 times or more in a minute without walking – a total of REBA Risk Score of 5 has been calculated. That figure corresponds with a "medium risk and requires precautions" level on REBA Risk Evaluation Table.

RESULTS AND DISCUSSION

Even though there are more than a hundred methods of risk assessment in the literature, mostly Finney Kinney or Matris methods are put into work by occupational health and safety professionals. In the chemical industries, the Hazop risk assessment method employs REBA and RULA methods to assess ergonomic posture of the workers. In the literature related to REBA and RULA ergonomic risk assessment method, studies in the fields such as construction and logistics can be found. This very study will indeed contribute to the REBA and RULA methods' applications. While other risk assessment methods calculate risks and dangers, they often tend to neglect employees' anatomical properties. Adjustment of the work to the employees-not employees' adjustment to the work- and reduction of occupational diseases are the main focus of ergonomical risk assessment.

In the study with fabric cutting saw, the REBA score was calculated as 6 and the risk level was determined as medium. The RULA risk score of the employee in the fabric sewing work was calculated as 4.The level of risk which the employee is exposed has been determined to require change. The risk to which the employee doing the quality control work is exposed was determined to be moderate, with a REBA score of 4.The risk score of the employee performing the stain removal work is 3 according to REBA. The level of risk exposure of workers is low and prevention may be required in the long term. According to the ergonomic risk analysis of the ironing employee, the REBA risk score is 6 and the risk level exposed is moderate, so it is necessary to take precautions. With a REBA score of 5, the risk level of the product packaging worker was medium.

By assessing apparel workshop employees' postures ergonomically, we can conclude the employees cutting fabric with saw, controlling the quality, doing the packaging and ironing face a medium level of danger according to the risk scores obtained and that there's the need to take precautions. It is established that the employee sewing the fabric with sewing machine faces varying levels of danger; the

stain removal employee faces a low level of danger while retaining the need to take possible precautions. According to the data obtained, having medium levels of danger doesn't necessarily mean the halt of the work. However, the muscular and skeletal diseases can be avoided in the medium or long run by taking necessary precautions.

The risks identified in the ergonomic risk analysis applied to the logistics sector by Kırcı and his colleagues indicate that there are 7 high-risk and 5 very high-risk working postures compared to those working in the textile sector, that those who do the work of pushing, pulling, lifting the load work in more dangerous jobs, and that the logistics sector is a more dangerous line of business. When the level of risks obtained as a result of the examination of the posture positions of the employees doing the cleaning work during the cleaning of outer glass and inner glass, sweeping and wiping of the floor is examined by Özay and Özcan, with the reveal of 4 medium risk 1 low risk risk levels it was determined that the risk levels of the posture positions of the employees in the textile sector with the cleaning workers are examined were close to each other [26].By examining the postures of the employees working in the ladle preparation process in the casting workshop with the Digital Human Modeling simulation in the CATIA V5 software by Erdemir and Eldem, the use of the Rapid Entire Body Assessment method which is an ergonomic risk assessment method, with the digital method, increases the accuracy of the study [5].When the studies in the literature are examined, it has been determined that the risks vary according to the basis of the work done.It has been determined that there are posture positions that include high and very high risks in the very dangerous line of business, medium and low risks in the works in the dangerous line of business, and more low risks and moderate risks in the less dangerous lines of business.

The academic study in the ergonomics will contribute to the literature by increasing the employees' performances, maintaining the safety, professional fulfillment and satisfaction by the work carried out.

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CONFLICT OF INTEREST

Authors approve that to the best of their knowledge, there is not any conflict of interest or common interest with an institution/organization or a person that may affect the review process of the paper.

AUTHOR CONTRIBUTION

Senol Yavuz; planning of the study, literature review, article the writing, evaluation of the results, concept, design. Berna Gur; article writing, literature review, journal research. Ahmet Dogan CAKIR; implementation of risk analysis, data collection and processing, evaluation of results. Dursun Ali KOSE; article writing, evaluation of results, review of the article.

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