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Ergonomics International Journal
ISSN: 2577-2953

# Risk Assessment of Ergonomic Factors in a Textile Firm by RULA, REBA and Fine Kinney Methods

**Aslan I[1]*, Hamitoğlu F[2], Acar MN[3] and Acar HA[4]**

[1]Associate Professor, Faculty of Health Sciences, Bingöl University, Türkiye

[2]B Class Occupational and Health Expert, Türkiye

[3]A Class Occupational and Health Expert, Türkiye

[4]Department of Occupational Health and Safety, Faculty of Health Sciences, Istanbul Yeni Yuzyıl University, Türkiye

**Research Article**

**Volume 9 Issue 1**

**Received Date:** January 29, 2025

**Published Date:** February 26, 2025

DOI: 10.23880/eoij-16000340

***Corresponding author:** Imran Aslan, Associate Professor, Faculty of Health Sciences, Bingöl University, Bingöl, Türkiye, Email: imranaslan@gmail.com

## Abstract

In the textile business, risks can lead to occupational musculoskeletal system diseases due to working on a machine for a long time in the same posture position. In this study, it was aimed to analyses the ergonomic risk of the employees by using the REBA (Rapid Entire Body Assessment), Rapid Upper Body Assessment (RULA) and Fine-Kinney risk assessment methods to find physical difficulties and overcome them in a textile firm, Diyarbakır, Türkiye. In this study, ergonomic risk assessments of people working in 20 different jobs were measured by REBA and RULA methods. In the same study, 19 different threats and risks were scored and evaluated by using the Fine-Kinney method. Snap making process and drawing process were high risks according to REBA method and quilting transport processes, print preview process, printing process, warehouse packaging process and roll fabric transportation process were found as the highest risks by RULA method. Failure to prevent employees from working in positions that strain the musculoskeletal systems and the lack of proper posture when taking products or parts carried by hand are scored as intolerable risks at overall. In this direction, necessary arrangements were made and solutions were offered to the stakeholders of the sector.

**Keywords:** Ergonomic Risk Factors; REBA; RULA; Fine Kinney; Occupational Health and Safety (OHS); Textile Sector

## Abbreviations

RULA: Rapid Upper Body Assessment; MSD: Musculoskeletal Disorders; OHS: Occupational Health and Safety; REBA: Rapid Whole-Body Assessment.

## Practitioner Summary

Many occupational musculoskeletal system problems and diseases were noticed in the textile sector. REBA, RULA and Fine-Kinney risk methods were used to assess the

[1]This article is derived from master thesis: Hamitoğlu F. Investigation of Ergonomic Risk Factors in a Textile Business in Terms of Occupational Health and Safety, Master Thesis , Istanbul, Türkiye: İstanbul Yeni Yüzyıl University, Institute of Health Sciences, Department of Occupational Health and Safety; 2021.

ergonomic risk factors. Using improperly body parts such as hands, legs and back and carrying loads can lead to lead to low performance and musculoskeletal disorders.

## Introduction

Employee performance has a significant impact on productivity and product quality in businesses. Ergonomic risk reasons occur due to long working hours, posture disorders, difficult work processes and the use of work pieces not suitable for the shape of the body. The work must be done according to anthropometric measurements, physical and personal characteristics. The purpose of ensuring of the work equipment is compatible with the person's abilities so that the employee is efficient and effective in his/her job. At workstations, the head, trunk, arms and legs are the most affected areas.

Employee performance is affected by the way the job done, working postures and the working environment. Work postures, which are expressed as the positioning of the worker's head, body, arms and legs, are some of the important ergonomic issues [1].

Poor working environment and inappropriate postures can lead to low performance and musculoskeletal disorders (MSD) [2]. Being in accordance with the characteristics and capacities of person using machine is defined with ergonomic term dealing with human body measurements, shape, and working capacity through considering the physical and mental characteristics and abilities with work and environmental conditions, human-machine interaction, and harmony of the physical environment. Ergonomics suiting the job to the employees is a multidisciplinary science such as anatomy, anthropometry, psychology etc [3]. In ergonomics, the effectiveness of the appropriate human-machine system can be increased by protecting human health through providing appropriate work distribution to the employee. The main goal in ergonomics is to reduce the physical difficulties that may occur.

Repetitive and forcible works and movements such as bending, tensioning, grasping, holding, rotating, compressing and reaching, improper working position, work environment, or lifting the excessive load can cause damage and injuries to tendons, muscles, nerves and other soft tissues and other MSD, resulting in labor, material and moral losses for employees, employers and the state and costs such as compensation and expenses incurred for the worker's treatment [2-4]. Situations as body movements of employees such as standing, lying down, bending, stretching, grasping, pushing, pulling, turning and reaching affect the performance and health of employees. Inappropriate positions cause pain and discomfort in employees' back, waist, neck and upper extremities (wrist, hand, elbow and shoulder). In addition, disorders occur in tendons, ligaments, joint junctions and especially discs. Disorders such as muscle strain and injury, stiff neck, cervical disc herniation, lumbar disc herniation, carpal tunnel syndrome, tense neck syndrome and muscle strength imbalances can be observed [2,5].

Ergonomic analyzes can be performed to detect inappropriate postures. The REBA and RULA methods have been recommended as a tool to easily analyze the risk status for study-related musculoskeletal disorders from an ergonomic perspective. Fine-Kinney method most widely applied to risk analyzing in Türkiye to all risk types is used as mathematical assessment method for accident control and it is different from other risk assessment methods with its a three-dimensional (probability-severity-frequency) risk assessment [2,6]. In the REBA method, all parts of the body are evaluated according to the loads. This method aims to identify postures that may cause occupational musculoskeletal disorders and to take necessary precautions [2]. Dynamic movements and fixed postures can be analyzed with the REBA method. The REBA method is preferred in works for both quantitative (bending, stretching) and qualitative (lateral turning, ease of grasping) of all parts of the body [2,4,5]. RULA (Rapid Upper Limb Assessment) is recommended in jobs where the strain on the employee's upper limbs and the pressure on the upper body is high and the load on the waist, back and legs is less such as dentists due to using the upper part of their body [5,7].

REBA, RULA and Fine Kinney risk assessment methods are used in many businesses and fields. Atasoy, et al. [8] made a study by creating risk scores using the REBA method in laboratory workers in a public hospital that musculoskeletal diseases were caused by repetitive physical movements, working in poor posture, repetitive and hard activities, long-term work without breaks and poor ergonomic conditions. Postures of employees doing heavy and dangerous work in various sectors [9], ergonomic risk assessment of workers working in a compressor manufacturing factory [4], ergonomic risk analysis of workstations in a cable production line [2], working postures on assembly lines [10], ergonomic risks exposed to bench workers in a rim factory [11], working postures of workers in the shipbuilding process [12] and an automotive production lines [3] are some studies used REBA method for ergonomic risk assessment in Türkiye. Work postures of employees with special needs (from birth or during the development process with different mental, physical, social and sensory developments) [13], ergonomic applications in a mold manufacturing company [14], ergonomic applications in the logistics warehouse sector [15], ergonomic contracting in general microbiology laboratories [16], and a medium-sized enterprise producing nuts [5] studies were carried out by using mixed both REBA and RULA methods in Türkiye. Moreover, REBA method has been widely applied to manufacturing and agriculture, forestry and fishing around the World [17]. REBA was applied among dental students using three digital photographs of the operator to determine chairside ergonomic risk by Raman, et al. [18] and Munavir, et al. [19] applied the REBA method to analyse non-ergonomic working postures in a flour mill. Maurer-Grubinger, et al. [20] and Aliakbari, et al. [21] examined the occupational health and ergonomic conditions of dentists using the RULA method. Fine-Kinney Method risk analysis study in terms of Occupational Health and Safety (OHS) was applied in the textile enterprise carrying out the work of bringing an integrated textile yarn into the desired form and turning it into fabric and adding color by Güngör M, et al. [22]. REBA method was applied by Atalay [23] to a textile cutting section and by Akyol [24] to the textile workshop in Türkiye. At the stage of ensuring OHS in textile enterprise; A common team was established from occupational safety experts, occupational physician, ergonomist experts, engineers and workers, and precautions were taken within the scope of holistic approaches. The holistic approach aims to optimize the relationship between human-machine-environmental conditions. As a result of ergonomic risk assessment in the workplace, work postures in the textile workshop were examined and the effects of work postures on musculoskeletal system diseases were observed. This study aimed to identify and evaluate possible hazards and risks in a textile firm by applying three most widely methods: REBA, RULA and Fine Kinney through focusing mainly on ergonomic risk factors.

### Textile Sector

The textile sector covers the section from fiber to yarn and finished fabric, while the process from fabric to clothing also falls into the field of ready-made clothing. Textile sector covers a wide range of production in the clothing industry's supply chain. Products for all kinds of needs: fibers, yarns, knitted fabrics, felt and tufting surfaces, home textiles, carpets, etc. are in the textile industry [25]. Products ready for end use; clothing products such as socks, sweaters, shirts, trousers and suits; home textiles such as curtains, sheets, carpets and other textile floor coverings and other textile products such as nets, ropes, cables, conveyor belts, tarpaulins, protective cloths, filters, parachutes, brake cloths and felts are classified as ready-made goods [26]. The ready-made clothing industry includes the process of making clothing according to standard measurements, using intensive technological production techniques in the fabrics and accessories. It consists of mold preparation, mold removal, marker drawing, cutting, sewing, cleaning and finally ironing and packaging stages [27]. Most jobs in the production process in the clothing industry are still labor intensive. The production process, which has become more complex with the machinery and equipment used in production methods, especially in labor-intensive sectors, is a great importance in terms of worker health and safety in the workplace.

Work accidents and occupational diseases are the biggest problems of working life. According to SGK's 2012 work accident and disease statistics, the textile industry was the third sector with the most work accidents. It is thought that accidents and occupational diseases reported in the workplace were higher due to the high rate of unregistered employment in the textile and clothing sector [28].

### Ergonomic Working Order in the Textile Industry

Increasing competitive environment, inappropriate working postures, continuous and repetitive work, time pressure cause problems with the musculoskeletal system. In working life, one in four employees complains of back pain and one in five employees suffers from muscle pain. Carrying, lifting, holding, lowering, pushing, pulling, carrying or moving a load are the biggest causes of injury in the textile industry. Manual packaging can cause gradual deterioration of the musculoskeletal system or other gradual disorders, such as lower back pain or cuts or fractures resulting from accidents, as examples of acute trauma. Working in incorrect positions during activities such as spinning (threading, twisting), cutting, product inspection and packaging, repetitive movements, storage, inspection and processing are risks factors in textile industry [29,30].

The main problems experienced by the personnel who have worked in the textile industry for many years are back, waist and shoulder pain, burning pain in the hands, arms and elbows, neck straightening, skeletal-muscular system problems, pain in the feet and legs, and eye problems. Workers generally sitting down during sewing are constantly at the same position during working hours. Musculoskeletal system complaints are observed in almost all of the employees due to reasons such as working with hands, arms and eyes in the position and posture with the desks and chairs not being ergonomic and adjustable leading to height problems between the workbench and the chair, and sometimes under insufficient lighting in the environment. Similar problems exist for personnel who constantly work standing [24].

## Materials and Methods

The place where this study was conducted at a textile firm in December 2020, by detecting the dangers arising from working conditions in Çüngüş district of Diyarbakır province, Türkiye. Necessary permissions were taken from the owner of the firm and employees before starting investigations. The firm has a total area of 1700 meters$^2$, divided into two different locations, and has two location managers, a quality control officer, three technical personnel, a production monitoring officer, a part-time C class occupational safety expert, and a part-time workplace physician. It employs over 110 people. As a result of the hazards and risks observed from these personnel, opinions, suggestions, attitudes and behaviors were taken from them as basis in order to carry out risk assessment studies.

Machinery, equipment and apparatus used in the business consist of components such as packaging machine, hanging conveyor systems, tape placing apparatus, ball presser foot, unit and belt bridge, turning apparatus, piping attaching apparatus, steam heated princes, gathering foot, pocket hemming apparatus, notching tool, notch bomb, pop-up punch, snap punch, perforated button foot, numbering machine, zipper machine, fixing presses, interlining gluing press, buttonhole machine, loop separators and thread finger hook. There is a raw material acceptance section, workshop section, warehouse section, packaging section, stacking section and shipping section at the firm.

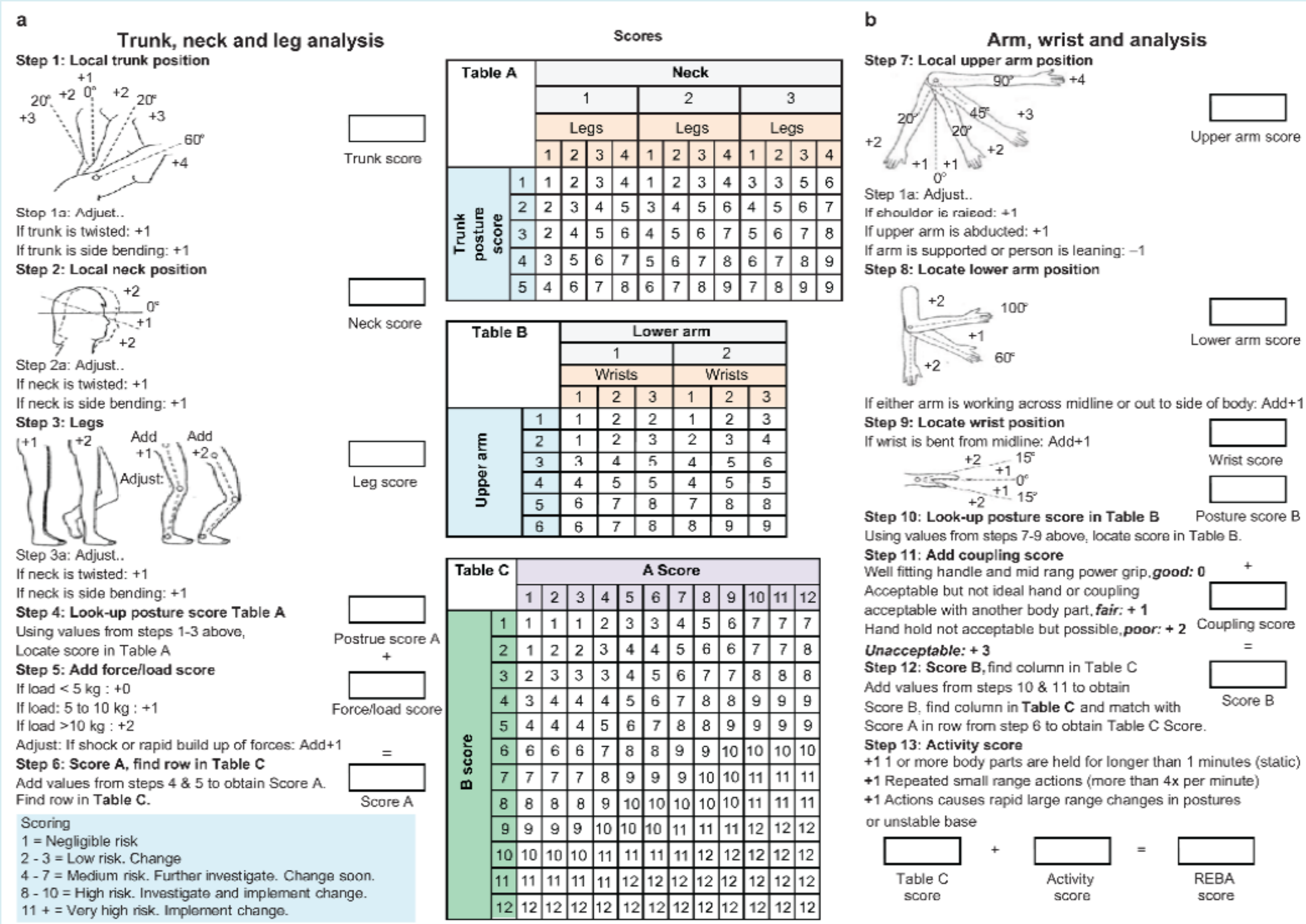
## Methods

This is one of the first study conducted in the textile sector in terms of risk calculation methods, using three different methods of risk assessment. These risk methods, which are mostly used in office work, were used in the textile field in this study. Rapid Whole-Body Assessment (REBA), Rapid Upper Body Assessment (RULA) and Fine Kinney risk assessment methods were used as ergonomic risk assessment methods. REBA and RULA analyzes were preferred in the study to ensure reliable and generalizable results and evaluations. Determining measures to prevent the development of work-related Musculoskeletal System Diseases (MSDs) seen in textile employees, developing solution suggestions by identifying the needs in this regard, and contributing information and data to the necessary studies on ergonomics are expected to be a step towards developmental studies. It has been prepared to determine the risks that occur in the context of hazards and to organize technical and organizational measures in order to reduce existing risks to acceptable risk levels by creating a risk priority ranking. This risk assessment procedure covers the employees of the textile enterprise, subcontractor or external service provider company employees, visitors, all workplace buildings and annexes, work equipment and all business activities, including logistics. This risk assessment procedure is regulated in accordance with the provisions of the *'6331 OHS Risk Assessment Regulation'*, which came into force within the scope of the OSH Law No. 6331in Türkiye.

In this study, photographs of the working positions of employees were taken and the necessary measurements were made for the analysis. Ergonomic analysis of many different tasks in our sample area regarding textile work has been carried out. REBA and RULA methods are selected as risk assessment methods for these tasks; Straight Stitch Process (P3), Button Sewing Process (P4), Curl Sewing Process (P5), Snap Making Process (P6), Drawing Process (P7), Conversion Process (P8), Marking and punctuation process (P9),: Ironing Straightening Process (P10) , Below Waist and Under Skirt Sewing Process (P11) , Hand Repair Process (P12), Quilting Transport Process I (P13), Quilting Transport Process II (P14), Cutting Process (P15), Print Preview Process (P16), Printing Process (P17), Drying Process (P18), Warehouse Packaging Process(P19), Roll Fabric Transportation Process (P20), Zipper Installation Process (P21), Button Installation Procedure(P22), the photos of which are shown in the Appendix.

### Rapid Whole-Body Assessment (REBA)

REBA was proposed by Hignett and McAtamney [31] as a tool to easily assess risk status for work-related musculoskeletal disorders without the need for advanced ergonomics or expensive equipment. REBA is an implementation method designed to respond to unpredictable positions, especially in the healthcare and other service sectors [4]. The ease of the load to be lifted, the way of gripping the load, how often the movement is made, whether the body remains stationary during the movement or whether it rotates or twists when it moves are important factor in that method [9,32]. The general risk during the work positions or movement can be measured numerically in REBA method. Numerical calculation of risk helps to separately predict the risks and dangerous situations caused by the analyzed work posture positions. Any given posture or movement state is divided into lower and upper body angles. The total score is calculated by adding neck, trunk, lower and upper extremity postures. When determining the REBA score of a working posture according to the REBA method, firstly the body parts were divided into groups as A and B (Figure 1).




| Table A | | Neck 1 | | | | Neck 2 | | | | Neck 3 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Legs | | | | Legs | | | | Legs | | | |
| | | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 |
| Trunk posture score | 1 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 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 B | | Lower arm 1 | | | Lower arm 2 | | |
|---|---|---|---|---|---|---|---|
| | | Wrists | | | Wrists | | |
| | | 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 | 6 |
| | 4 | 4 | 5 | 5 | 4 | 5 | 5 |
| | 5 | 6 | 7 | 8 | 7 | 8 | 8 |
| | 6 | 6 | 7 | 8 | 8 | 9 | 9 |

| Table C | | A Score | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| B 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 | 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 |

**Figure 1:** REBA implementation steps [32].
**Group A:** Torso, Neck, and Leg.
**Group B:** Upper arms, Lower arms, and Wrists.

### Rapid Upper Body Assessment (RULA)

Person's susceptibility to loads because of the posture of the upper extremity and spine with help of the lower extremities is assed to deal with extra load during one's work by RULA method. This method has scores ranges from one to seven that higher scores mean the greater possibility of the musculoskeletal problems and scores either equal to or greater than five require posture change [33]. RULA method was developed on the basis of a scoring system to evaluate workers under the influence of musculoskeletal loads causing upper extremity (hand-wrist-elbow-lower arm-upper arm-shoulder-neck) disorders and is designed to assist in a rapid analysis of the load on a worker's upper extremities. It allows objective measurement of the risk of musculoskeletal disorders caused by jobs where the pressure on the body is high and the pressure on the rest, that is, the load on the back, waist and legs, is relatively low. RULA method is one of the subjective observation methods that scores working postures and developed to detect upper extremity disorders that occur due to the nature of the work, considering the power and repetitive movements required by the work [34,35] (Figure 2).

### Fine Kinney Method

The Fine Kinney method is recommended because it is an easy method to use and widely applied to all risk assessments in Türkiye. It has wide range values and three parameters shown in Table 1 [6]. Fine Kinney risk assessment method is obtained by multiplying probability, severity and frequency values and interpreting the resulting score according to Fine–Kinney risk situation. Probability values: 0.1, 0.2, 0.5, 1, 3, 6, 10; frequency values: 0.5, 1, 2, 3, 6, 10; Severity values: given as 1, 3, 7, 15, 40 and 100 are given (Table 1).

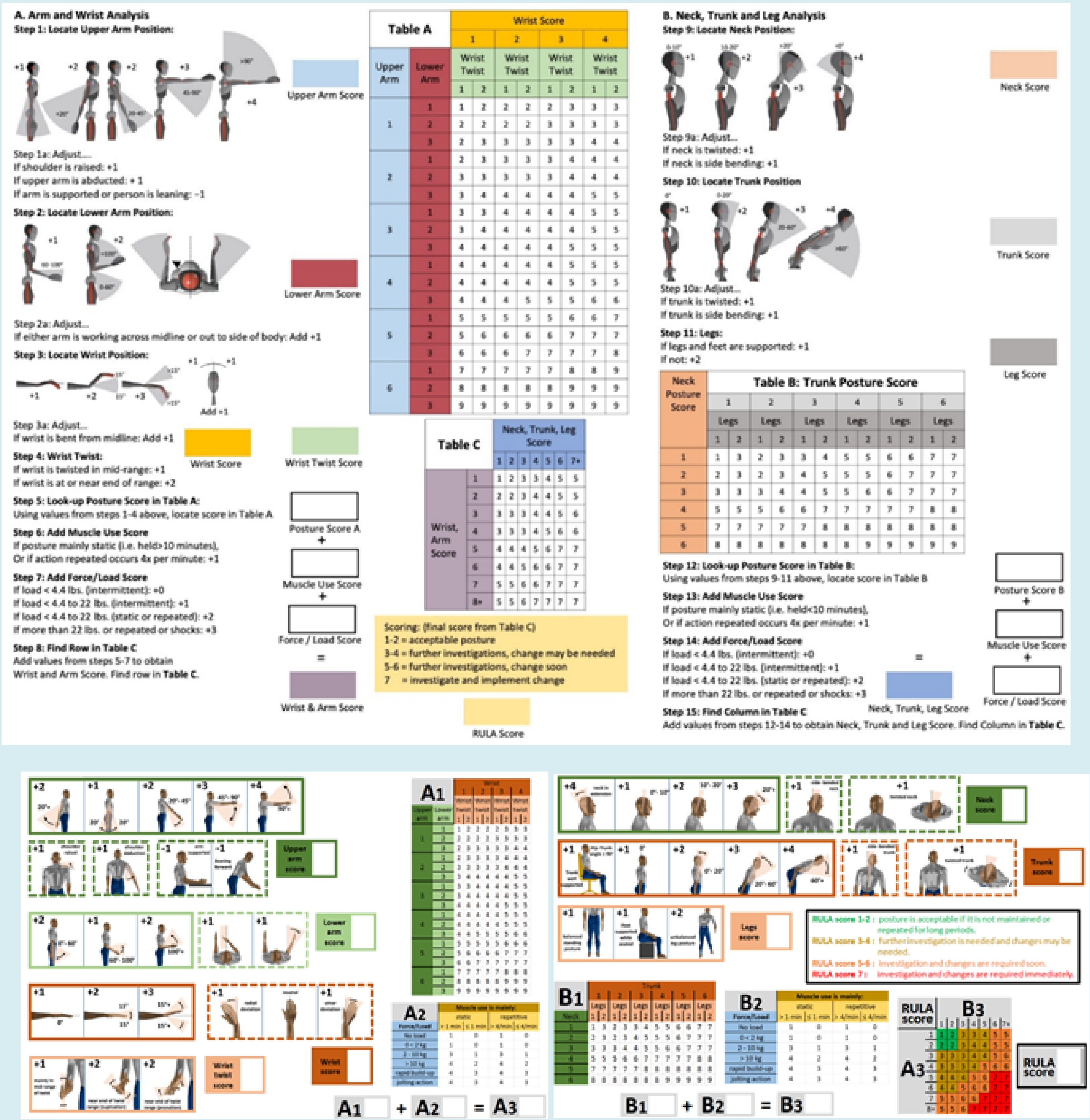



**Figure 2:** RULA worksheet including all relevant steps [20].

| Likelihood of a Hazardous Event | | Exposure Factor | | Possible Consequences | |
|---|---|---|---|---|---|
| Probability | **Value** | **Frequency** | **Value** | **Severity** | **Value** |
| "Might well be expected" | 10 | "Continuous" | 10 | "Catastrophe (many fatalities)" | 100 |
| "Quite possible" | 6 | "Frequent (daily)" | 6 | "Disaster (few fatalities)" | 40 |
| "Unusual but possible" | 3 | "Occasional (weekly)" | 3 | "Very serious (fatality)" | 15 |
| "Only remotely possible" | 1 | "Unusual (monthly)" | 2 | "Serious (serious injury)" | 7 |
| "Conceivable but very unlikely" | 0.5 | "Rare (a few per year)" | 1 | "Important (disability)" | 3 |
| "Practically impossible" | 0.2 | "Very rare (yearly)" | 0.5 | "Noticeable (minor first aid accident)" | 1 |
| "Virtually impossible" | 0.1 | | | | |
| **Fine–Kinney risk score** | | **Fine–Kinney risk situation** | | | |
| > 400 | | "Very high risk; consider discontinuing operation" | | | |
| 200–400 | | "High risk; immediate correction required" | | | |
| 70–200 | | "Substantial risk; correction needed" | | | |
| 20–70 | | "Possible risk; attention indicated" | | | |
| < 20 | | "Risk; perhaps acceptable" | | | |

**Table 1:** Fine Kinney scoring chart [36].

## Results

### REBA and RULA Methods Applications

The performed works shown in Appendix section are constantly repeated and sometimes requires force. The process of drawing requires the employee to lean forward in front of a desk and work constantly. In addition, drawing or cutting work is a very laborious job requiring superior skill that health problems such as varicose veins seen over long periods of time due to long-term standing work may occur. People working in the ironing and straightening process put in a lot of efforts. In the under-waist and under-skirt sewing process, the person working must constantly apply force to the machine pedal located at the bottom of the bench.

Constantly using the same working posture can cause musculoskeletal disorders and back pain in the long term. The person working in hand repair and hand sewing can take very different stances because they do not always stay in the same stance due to the small number of products or parts used for this process. Preparation, transportation, removal and relocation of quilted products or parts are carried out by human power. Since there are many products or parts in the print preview process, this process sometimes becomes very fast and requires the employee to constantly lean forward. The print preview processing machine makes it possible to have nearly thirty products or parts ready for printing at the same time. The large number of products or parts coming to the warehouse packaging process may cause the person working in this process to have a very non-ergonomic posture on the workbench. The zippers used in the zipper installation process are manually cut by the employee with scissors to certain lengths according to their design. Excessive and long-term use of scissors causes the right and left hands to work more than necessary.

When the works carried out throughout the enterprise are examined, 4 of the works (button sewing process, marking and punctuation process, below waist and under skirt sewing process and hand repair process) by the REBA method are low risks and may require changes; 4 processes (Straight stitch process, curl sewing process, conversion process and ironing straightening process) are medium risks, requiring detailed investigations and urgent change. While, 2 processes (Snap making process and drawing process) are high risk, may require reassessment and change in practice soon Table 2.

| Straight Stitch Process (P3) | | Button Sewing Process (P4) | | Curl Sewing Process(P5) | | Snap Making Process (P6) | | Drawing Process(P7) | |
|---|---|---|---|---|---|---|---|---|---|
| **Table A** | | **Table A** | | **Table A** | | **Table A** | | **Table A** | |
| Trunk | 2 | Trunk | 2 | Trunk | 2 | Trunk | 2 | Trunk | 3 |
| Neck | 2 | Neck | 1 | Neck | 2 | Neck | 3 | Neck | 3 |
| Legs | 1 | Legs | 1 | Legs | 1 | Legs | 3 | Legs | 1 |
| Table A | 3 | Table A | 2 | Table A | 3 | Table A | 6 | Table A | 3 |
| Load/Force Rating | 0 | Load/Force Rating | 0 | Load/Force Rating | 0 | Load/Force Rating | 0 | Load/Force Rating | 0 |
| **A Score** | 3 | **A Score** | 2 | **A Score** | 3 | **A Score** | 6 | **A Score** | 5 |
| **Table B** | | **Table B** | | **Table B** | | **Table B** | | **Table B** | |
| Upper Arms | 3 | Upper Arms | 2 | Upper Arms | 3 | Upper Arms | 3 | Upper Arms | 3 |
| Lower Arms | 1 | Lower Arms | 1 | Lower Arms | 1 | Lower Arms | 2 | Lower Arms | 3 |
| Wrists | 2 | Wrists | 2 | Wrists | 2 | Wrists | 2 | Wrists | 2 |
| Table B | 4 | Table B | 2 | Table B | 4 | Table B | 5 | Table B | 5 |
| Coupling Score | 1 | Coupling Score | 1 | Coupling Score | 1 | Coupling Score | 1 | Coupling Score | 1 |
| **B Score** | 5 | **B Score** | 3 | **B Score** | 5 | **B Score** | 6 | **B Score** | 6 |
| **C Score** | 4 | **C Score** | 2 | **C Score** | 4 | **C Score** | 8 | **C Score** | 7 |
| Activity Score | 1 | Activity Score | 1 | Activity Score | 1 | Activity Score | 1 | Activity Score | 1 |
| **Reba Score** | **5** | **Reba Score** | **3** | **Reba Score** | **5** | **Reba Score** | **9** | **Reba Score** | **8** |
| **Conversion Process (P8)** | | **Marking and Punctuation Process (P9)** | | **Ironing Straightening Process (P10)** | | **Below Waist and Under Skirt Sewing Process (P11)** | | **Hand Repair Process (P12)** | |
| **Table A** | | **Table A** | | **Table A** | | **Table A** | | **Table A** | |
| Trunk | 2 | Trunk | 1 | Trunk | 2 | Trunk | 1 | Trunk | 2 |
| Neck | 2 | Neck | 1 | Neck | 2 | Neck | 1 | Neck | 2 |
| Legs | 2 | Legs | 2 | Legs | 1 | Legs | 1 | Legs | 1 |
| Table A | 4 | Table A | 2 | Table A | 3 | Table A | 1 | Table A | 3 |
| Load/Force Rating | 0 | Load/Force Rating | 0 | Load/Force Rating | 1 | Load/Force Rating | 0 | Load/Force Rating | 0 |
| **A Score** | 4 | **A Score** | 2 | **A Score** | 4 | **A Score** | 1 | **A Score** | 3 |
| **Table B** | | **Table B** | | **Table B** | | **Table B** | | **Table B** | |
| Upper Arms | 3 | Upper Arms | 2 | Upper Arms | 2 | Upper Arms | 2 | Upper Arms | 1 |
| Lower Arms | 2 | Lower Arms | 1 | Lower Arms | 1 | Lower Arms | 1 | Lower Arms | 2 |
| Wrists | 3 | Wrists | 1 | Wrists | 2 | Wrists | 2 | Wrists | 1 |
| Table B | 5 | Table B | 1 | Table B | 2 | Table B | 2 | Table B | 1 |
| Coupling Score | 1 | Coupling Score | 1 | Coupling Score | 1 | Coupling Score | 0 | Coupling Score | 0 |
| **B Score** | 6 | **B Score** | 2 | **B Score** | 3 | **B Score** | 2 | **B Score** | 1 |
| **C Score** | 6 | **C Score** | 2 | **C Score** | 4 | **C Score** | 1 | **C Score** | 2 |
| Activity Score | 1 | Activity Score | 1 | Activity Score | 1 | Activity Score | 1 | Activity Score | 1 |
| **Reba Score** | 7 | **Reba Score** | 3 | **Reba Score** | 5 | **Reba Score** | 2 | **Reba Score** | 3 |

**Table 2:** Ergonomic risk assessments made with the REBA method.

Four processes (Drying process, print preview process, zipper installation process and button installation procedure) may require further research and modification according to the RULA method shown in Table 3. Six processes (Quilting transport process I, quilting transport process II, print preview process, printing process, warehouse packaging process, roll fabric transportation process) with highest risk require further researches and implementing change and scores either equal to or greater than five require posture change. Ergonomic designs making work easier and will not endanger the employee and work processes during the execution of the work should be developed and implemented for these processes.

According to the REBA analysis, during the snap-making process, the score was 9, which indicates that there may be an ergonomic risk in the sitting posture. According to the RULA analysis of the print preview process, obtaining a risk score of 7 indicates that the employee who is in constant and repetitive standing posture may face problems with skeletal system, waist and neck disorders. Moreover, according to the RULA analysis during the quilting transportation process, the risk score was 7 and it was determined that even a worker with average body size could develop MSD problems in the long term.

| **Quilting Transport Process I (P13)** | | **Quilting Transport Process II (P14)** | | **Cutting Process(P15)** | | **Print Preview Process(P16)** | | **Printing Process (P17)** | |
|---|---|---|---|---|---|---|---|---|---|
| **Table A** | | **Table A** | | **Table A** | | **Table A** | | **Table A** | |
| Upper Arm Score | 3 | Upper Arm Score | 2 | Upper Arm Score | 2 | Upper Arm Score | 3 | Upper Arm Score | 2 |
| Lower Arm Score | 2 | Lower Arm Score | 3 | Lower Arm Score | 2 | Lower Arm Score | 2 | Lower Arm Score | 3 |
| Wrist Score | 3 | Wrist Score | 2 | Wrist Score | 1 | Wrist Score | 3 | Wrist Score | 2 |
| Wrist twist score | 2 | Wrist twist score | 1 | Wrist twist score | 1 | Wrist twist score | 2 | Wrist twist score | 1 |
| Table A | 4 | Table A | 4 | Table A | 3 | Table A | 4 | Table A | 4 |
| Force/Load Score | 3 | Force/Load Score | 3 | Force/Load Score | 1 | Force/Load Score | 3 | Force/Load Score | 3 |
| Muscle Use | | Muscle Use | | Muscle Use | | Muscle Use | | Muscle Use | |
| **A Score** | 7 | **A Score** | 7 | **A Score** | 4 | **A Score** | 7 | **A Score** | 7 |
| **Table B** | | **Table B** | | **Table B** | | **Table B** | | **Table B** | |
| Neck Score | 2 | Neck Score | 1 | Neck Score | 1 | Neck Score | 2 | Neck Score | 1 |
| Trunk Score | 3 | Trunk Score | 2 | Trunk Score | 1 | Trunk Score | 3 | Trunk Score | 2 |
| Leg Score | 1 | Leg Score | 1 | Leg Score | 1 | Leg Score | 1 | Leg Score | 1 |
| Table B | 4 | Table B | 2 | Table B | 1 | Table B | 4 | Table B | 2 |
| Force/Load Score | 3 | Force/Load Score | 3 | Force/Load Score | 1 | Force/Load Score | 3 | Force/Load Score | 3 |
| Muscle Use | | Muscle Use | | Muscle Use | | Muscle Use | | Muscle Use | |
| **B Score** | 7 | **B Score** | 5 | **B Score** | 2 | **B Score** | 7 | **B Score** | 5 |
| **C Score** | 7 | **C Score** | 7 | **C Score** | 3 | **C Score** | 7 | **C Score** | 7 |
| **Rula Score** | 7 | **Rula Score** | 7 | **Rula Score** | 3 | **Rula Score** | 7 | **Rula Score** | 7 |
| **Drying Process (P18)** | | **Warehouse Packaging Process (P19)** | | **Roll Fabric Transportation Process (P20)** | | **Zipper Installation Process (P21)** | | **Button Installation Procedure (P22)** | |
| **Table A** | | **Table A** | | **Table A** | | **Table A** | | **Table A** | |
| Upper Arm Score | 2 | Upper Arm Score | 3 | Upper Arm Score | 2 | Upper Arm Score | 2 | Upper Arm Score | 2 |
| Lower Arm Score | 2 | Lower Arm Score | 3 | Lower Arm Score | 2 | Lower Arm Score | 2 | Lower Arm Score | 2 |
| Wrist Score | 1 | Wrist Score | 3 | Wrist Score | 2 | Wrist Score | 3 | Wrist Score | 3 |
| Wrist twist score | 1 | Wrist twist score | 2 | Wrist twist score | 2 | Wrist twist score | 2 | Wrist twist score | 2 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Table A | 3 | Table A | 5 | Table A | 3 | Table A | 4 | Table A | 4 |
| Force/Load Score | 1 | Force/Load Score | 2 | Force/Load Score | 3 | Force/Load Score | 1 | Force/Load Score | 1 |
| Muscle Use | | Muscle Use | | Muscle Use | | Muscle Use | | Muscle Use | |
| **A Score** | 4 | **A Score** | 7 | **A Score** | 6 | **A Score** | 5 | **A Score** | 5 |
| **Table B** | | **Table B** | | **Table B** | | **Table B** | | **Table B** | |
| Neck Score | 1 | Neck Score | 3 | Neck Score | 1 | Neck Score | 3 | Neck Score | 2 |
| Trunk Score | 1 | Trunk Score | 3 | Trunk Score | 1 | Trunk Score | 2 | Trunk Score | 2 |
| Leg Score | 1 | Leg Score | 1 | Leg Score | 2 | Leg Score | 1 | Leg Score | 1 |
| Table B | 1 | Table B | 4 | Table B | 3 | Table B | 3 | Table B | 2 |
| Force/Load Score | 1 | Force/Load Score | 2 | Force/Load Score | 3 | Force/Load Score | 0 | Force/Load Score | 0 |
| Muscle Use | | Muscle Use | | Muscle Use | | Muscle Use | | Muscle Use | |
| **B Score** | 2 | **B Score** | 6 | **B Score** | 6 | **B Score** | 3 | **B Score** | 2 |
| **C Score** | 3 | **C Score** | 7 | **C Score** | 7 | **C Score** | 4 | **C Score** | 4 |
| **Rula Score** | 3 | **Rula Score** | 7 | **Rula Score** | 7 | **Rula Score** | 4 | **Rula Score** | 4 |

**Table 3:** Risk assessments made with the RULA method.

### Fine - Kinney Method Application

Risk analysis studies on 19 identified risks and hazards in the field of ergonomics are given in Table 4. Not preventing employees from working in positions that strain their muscular and skeletal systems (Risk 5) and lack of proper body posture when picking up products or parts carried by hand (Risk 15) with very high-risk scores need urgent attention at the firm, they may be considered as discontinuing operations. Different methods or techniques can be applied to prevent employees from working in straining positions. Appropriate posture when picking up or carrying hand-held products or parts can be applied. Employees may need further training about these both risks.

The workbench not at sufficient and appropriate working height (Risk 1), not all areas internally arranged (Risk 3), lack of lifting gear or means of transport (Risk 4), reaching up or bending down to remain motionless in the same position for a long time (Risk 7), not arranging and organizing work areas according to themselves by employees (Risk 9), performing repetitive movements while the other part fixed for a long time (Risk 12), working or standing in the same position for a long time(Risk 13), manual lifting, pulling or pushing of heavy machinery and equipment (Risk 15) and not using the personal protective equipment because of being unsuitable (Risk 18) were high risks requiring immediate corrections.

Substantial risks need corrections that their risks can be decreased in longer time. Corrective/preventive action to be taken are given for these high risks to decrease high risks to acceptable risk levels in Table 4.

### Comparing Rapid Upper Body Assessment (RULA) and Fine Kinney risk assessment methods

Roll Fabric transportation process (P20) shown in Appendix having 7 RULA highest score shown in Table 3 was also evaluated by Fine Kinney risk assessment method as shown in Table 5. According to the evaluation table of RUL A method; Research and change are required. In the roll fabric transportation process, the products or parts that are in the process of being transported or lifted are generally manufactured with an average length of 150 meters and between 15-45 kilograms, while the top siphon fabric has an average length of 80 meters and between 15-45 kilograms. Long-term musculoskeletal disorders and varicose vein formation may occur in people working in the fabric handling process, as a result of constantly maintaining the same stance and posture. It is extremely important that machinery, tools and equipment, rather than more manpower, are needed to perform such operations.

When Roll fabric transportation process is analyzed by Fine Kinney method, three threats causing to musculoskeletal disorders – back and neck injury – damage, injury, loss of limb, death were determined as shown in Table 5. Corrective/ Preventive Action to be taken by Fine Kinney method are presented below to decrease high and possible risks to " Acceptable risk " level.

- A lifting device or means of transportation can be provided to prevent improper lifting, pushing or pulling of heavy loads. With the regulatory and preventive activities carried out, heavy loads can be prevented from being lifted, carried, pulled or pushed in an inappropriate posture, and heavy loads can be transported with a suitable lifting device or equipment. The probability value is reduced to 0.5 and the intensity and frequency values are kept constant. As a result, a risk score of 0.5x15x3=22.5 was obtained and the risk level was reduced to the " Acceptable risk " level.

- Roll fabrics will be stacked in designated places and maximum storage limits will not be exceeded. The anti-regulatory roll fabrics made will be stacked in designated places and by preventing the maximum storage limits from being exceeded, the probability value is reduced to 1 and the frequency and intensity values are kept constant. As a result, a risk score of 1x15x3=45 was obtained and the risk level was reduced to the " Possible risk " level.
- If the heavy bulk fabrics are to be transported by human hands, the task is distributed to more than one person, planning is done and precautions are taken for the transportation, the probability value is reduced to 0.5 and the frequency and intensity values are kept constant. As a result, a risk score of 0.5x15x6=90 was obtained and the risk level was reduced to the " Substantial risk" level.

Heavy bulk fabrics were carried by one person (TH3) was seen as the high risk requiring immediate corrections. Factors affecting one process analyzed by RULA method can be due to many threats when analyzed by Fine Kinney method as shown in Table 5. Improper stacking and storage of bulk fabrics, carrying, pushing or relocation of heavy bulk fabrics and carrying by one person can affect the ergonomics of persons of roll fabric transportation process. Hence, Fine Kinney method can be applied to find causes-Effects Analysis of Risk Factors Supported RULA Method (Table 4).

| No | Threat | Assessment of Current Risk | | | | | Corrective/Preventive Action to Be Taken | Risk Assessment After Corrective/Preventive Action | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Possibility | Frequency | Severity | Risk Value | Definition of Risk | THREAT | Possibility | Frequency | severity | Risk Value | Definition of Risk |
| 1 | The workbench is not at sufficient and appropriate working height | 6 | 3 | 15 | **270** | HR | There should be appropriately constructed and sufficient number of workbenches for employees to use. | 0,5 | 3 | 15 | **22.5** | AR |
| 2 | Sitting, standing or doing repetitive work for long periods of time | 3 | 6 | 7 | **126** | SR | Sitting, standing or doing repetitive work for long periods of time will be prevented. | 0,5 | 6 | 7 | **21** | AR |
| 3 | Not all areas are internally arranged, excessive reaching requirements are not eliminated, and not all items or materials are easily accessible. | 6 | 3 | 15 | **270** | HR | The interior arrangement of all areas will be made, excessive reaching requirements will be eliminated and all items or materials will be ensured to be easily accessible. | 0,5 | 3 | 15 | **22.5** | AR |
| 4 | Lack of lifting gear or means of transport to prevent improper lifting, pushing or pulling of heavy loads | 6 | 6 | 7 | **252** | HR | A lifting device or means of transportation will be provided to prevent improper lifting, pushing or pulling of heavy loads. | 1 | 6 | 7 | **42** | AR |
| 5 | Not preventing employees from working in positions that strain their muscular and skeletal systems | 6 | 6 | 15 | **540** | VHR | Employees will be prevented from working in positions that strain their muscular and skeletal systems. | 0,5 | 6 | 15 | **45** | AR |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6 | Lack of information about ergonomics in the workplace | 3 | 3 | 15 | **135** | SR | Employees will be provided with training and information on ergonomics issues. | 0,5 | 3 | 15 | **22.5** | AR |
| 7 | Not preventing employees who work in jobs that require reaching up or bending down to remain motionless in the same position for a long time. | 6 | 3 | 15 | **270** | HR | Employees who work in jobs that require reaching up or bending down will be prevented from remaining in the same position for a long time. | 1 | 3 | 15 | **45** | AR |
| 8 | No footrests or chair reinforcements to avoid working standing for long periods of time | 3 | 6 | 7 | **126** | SR | Chairs will be provided for staff who work standing, changes will be made for staff who work sitting all the time. | 1 | 6 | 7 | **42** | AR |
| 9 | Employees do not have the opportunity to arrange and organize their work areas according to themselves | 6 | 6 | 7 | **252** | HR | Employees will be provided with the opportunity to arrange and organize their work areas according to their own needs. | 1 | 6 | 7 | **42** | AR |
| 10 | The working environment does not have space where employees can move easily | 3 | 3 | 15 | **135** | SR | The working environment will be designed to ensure proper movement for employees. | 1 | 3 | 15 | **45** | AR |
| 11 | Failure to provide employees with tables, chairs or support equipment suitable for the work they do | 6 | 3 | 7 | **126** | SR | Employees will be provided with tables, chairs or support equipment suitable for the work they do. | 0,5 | 3 | 7 | **10.5** | AR |
| 12 | The requirement of the job is to perform repetitive movements with a certain part of the body while the other part is fixed, very frequently and for a long time. | 6 | 3 | 15 | **270** | HR | As a requirement of the job, while a certain part of the body is stationary, frequent and long-term repetitive movements with the other part will be prevented. | 1 | 3 | 15 | **45** | AR |
| 13 | If working or standing in the same position for a long time, changing tasks or not giving body rest at regular intervals | 6 | 6 | 7 | **252** | HR | If working in the same position for a long time, task change or continuous breaks will be used. | 1 | 6 | 7 | **42** | AR |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 14 | Misuse of hand tools or not using the right tool for the job | 3 | 6 | 7 | **126** | SR | The hand tools used will be suitable for use, and information will be provided to ensure the correct use of misused hand tools. | 0,2 | 6 | 7 | **8.4** | AR |
| 15 | Manual lifting, pulling or pushing of heavy machinery and equipment used from time to time | 6 | 3 | 15 | **270** | HR | The heavy machinery and equipment used will be lifted by lifting tools suitable for the job or by people assigned to the task. | 1 | 3 | 15 | **45** | AR |
| 16 | Lack of proper body posture when picking up products or parts carried by hand | 6 | 6 | 15 | **540** | VHR | The body must be in appropriate posture when picking up or carrying hand-held products or parts. | 0,5 | 6 | 15 | **45** | AR |
| 17 | Sewing machine apparatus and equipment should not be installed or placed with hand tools. | 3 | 3 | 15 | **135** | SR | Where necessary, hand tools suitable for the work to be done will be used to mount or place machinery and equipment. | 0,2 | 3 | 15 | **9** | AR |
| 18 | Persons cannot use the personal protective equipment used as a result of it being unsuitable. | 3 | 6 | 15 | **270** | HR | It should be ensured that personal protective equipment suitable for use and suitable for the people who will use it are available. | 0,5 | 6 | 15 | **45** | AR |
| 19 | Foot pedals of sewing machines are not maintained or adjusted | 6 | 3 | 7 | **126** | SR | It should be ensured that the foot pedals on sewing machines are comfortable and useful during use. | 1 | 3 | 7 | **21** | AR |

Definition of Risk; Very high risk (VHR) = >400; High risk (HR) = 200–400; Substantial risk (SR) = 70–200; Possible risk (PR) = 20–70; Acceptable risk (AR) = <20

**Table 4:** Sample risk analysis study on ergonomics issues in the textile business using the Fine Kinney method.

| Threat No | Threat | Risk | Possibility | Frequency | Severity | Risk Value | Definition of Risk |
|---|---|---|---|---|---|---|---|
| TH1 | Improper carrying, pushing or relocation of heavy bulk fabrics is done by human power. | Musculoskeletal disorders – back and neck injury – damage, injury | 3 | 15 | 3 | **135** | Possible risk |
| TH2 | Improper stacking and storage of bulk fabrics | Crushing, tipping over, loss of limb, injury, death | 3 | 15 | 3 | **135** | Possible risk |
| TH3 | Heavy bulk fabrics are carried by one person | Musculoskeletal disorders – back and neck injury – damage, injury | 3 | 15 | 6 | **270** | High risk |

Definition of Risk = Very high risk (VHR) = >400; High risk (HR) = 200–400; Substantial risk (SR) = 70–200; Possible risk (PR) = 20–70; Acceptable risk (AR) = <20.

**Table 5:** Roll Fabric Transportation Process by Fine Kinney.

## Discussion

The aging of workers increases the possibility of work-related musculoskeletal disorders particularly in the trunk, shoulder, and hand/wrist accompanied by pain, leading to a severe reduction in the labor force [37]. In the evaluation, it was seen that the risk analysis of the company was at a medium level in a textile workshop. It was concluded that employees in the firm may be exposed to skeletal muscle system disorders [24]. The majority of processes by REBA method were medium risks while seven processes analyzed by the RULA method are mainly high risks in that study. Snap making process and drawing process are high risk by REBA method. Quilting transport process I, quilting transport process II, print preview process, printing process, warehouse packaging process and roll fabric transportation process are high risks by RULA method. Attention is to be given high risks and then medium risks are to be minimized. Working in positions that strain their muscular and skeletal systems and lack of proper body posture when picking up products or parts carried by hand were found through Fine Kinney method as very high-risk scores needing urgent attention and some new methods are to be developed to overcome these problems.

A mechanism can be arranged under the machines of tall employees to raise the height of the table. In some cases, the employee must turn his or her body a lot to pick up the material and the part to be sewn from the side of the table. For this reason, it can always be beneficial to have the material or parts to be sewn in the employee's normal work area. Since the chair height of short employees is not adjusted, their elbows and wrists are not at the correct angle. The fact that they do not lean back causes their backs to be hunched. The back support can prevent the employee from slouching [24]. Prolonged standing If possible, these tasks can be done sitting or the employee can be given more frequent breaks. What kind of exercise program should be followed against musculoskeletal system problems should be carefully evaluated by the workplace physician and occupational safety specialist in that firm.

The suggested postures are also valid to ensure quality of life during movements such as lifting, pushing and pulling materials in daily life. It is inevitable not to take ergonomic risks while doing this job in working life or daily life. Doctors and job analysts at the workplace advise employees on certain work, training, nutrition, necessary rest periods for the body, exercise movements and durations, etc., in order to eliminate or reduce the problems that the spine will cause to employees in the coming years [15]. It is known that appropriate workplace design, periodic rest hours and the use of full protective equipment can help sewing machine users in preventing the onset of MSD [38].

Even if the break period is not extended, employees can take breaks alternately and the physical health of the employee can be protected while preventing work disruptions [24]. There should be appropriately constructed and sufficient number of work benches for employees to use. Sitting, standing or doing repetitive work for long periods of time can be prevented. By making internal arrangements of the entire area, the extra reaching needs of working people can be prevented and tools, equipment and equipment can be ensured to be accessible. Heavy loads can be transported with a suitable lifting device or equipment to prevent lifting, carrying, pulling or pushing heavy loads in an inappropriate posture. People who work in jobs requiring reaching too high or bending down too much can be decreased from remaining in the same motionless posture for a long time. Chairs can be provided for staff standing and also changes can be made for staff sitting all the time.

It should be ensured that personal protective equipment suitable for use and suitable for the people who will use it are available. It should be ensured that the foot pedals on sewing machines are comfortable and useful during use. The hand tools can be suitable for use, and information can be provided to ensure the correct use of misused hand tools. The heavy machinery and equipment can be used by lifting tools suitable for the job or by people assigned to the task. The body must be in appropriate posture when picking up or carrying hand-held products or parts. Where necessary, hand tools suitable for the work to be done can be used to mount or place machinery and equipment. According to Kırcı [15], awareness campaigns should be carried out by working with the management system to avoid inappropriate positions where danger and risks the most important parameters of health and safety in the workplace, become accustomed over time. Since the person does not have the ability to constantly control himself during the execution of business processes during the day, it is a very effective task for the employer to include other colleagues in this work during the day, make observations, necessary warnings, and model and activate systems that can be implemented by other colleagues in the business culture. As a result, it has been determined that legal obligation is one of the main reasons why employees attend training and a significant portion of them participate in order to avoid possible punishment in the future. In addition, it has been observed that employees prefer practical training supported by visual materials, which include examples of very specific work steps they have done themselves. Ergonomics information on the subjects specified in the regulation is superficial information. Employees should be trained ergonomically at regular intervals. In addition to the work done in work processes, wrong work examples and dangers should also be included in the training. Although the exact number of occupational diseases is unknown in our country, factors affecting spine health can cause cumulative trauma diseases.

Well-optimized work routines with an automated RULA and REBA methods can be analyzed with kinematic data captured by inertial sensors called as motion detection with inertial sensor technology to quantify angles and subsequently set thresholds such as thresholds for arm abduction, radial or ulnar abduction with accurate analysis [20]. Excess product and production factors create excess heat and heat cramps in terms of thermal comfort on workers. Excess heat and heat cramps cause serious occupational diseases in people who work for many years. The effects of heat-causing sources on the work area should be reduced by increasing the working area or reducing the excess of machinery, tools and equipment. In workshops and factories where, natural ventilation cannot be used, ventilation and air transfer systems can be planned. The clothes used by the working personnel should be suitable for the environment and allow the resulting body fluid to move away from the skin to provide ergonomic comfort. Works on Mondays and shift start times, when work accidents are most common, should be gradually increased starting from the first work start time. Employees should consume adequate amounts of fluids whenever possible.

### Implications of Findings

There can be significant implications for ergonomics and worker safety from the results of a study using RULA, REBA and the Fine Kinney Method for risk assessment in a textile company. High RULA results indicate that workers may be exposed to poor posture or excessive force when performing tasks such as sewing or lifting cloth, which may result in musculoskeletal disorders. Findings of high REBA scores indicate that workers may be at risk of strains to the lower back, legs or shoulders and may require job modifications. The results of this study suggest that the REBA and RULA risk analysis methods can be effectively applied in the textile sector. The management of the textile companies can make use of these findings to improve the ergonomic conditions of the workers in order to increase their efficiency and comfort. Workplace redesign, job rotation and rest breaks can be used to improve the ergonomic conditions of all workers in all industries in order to prevent muscle fatigue and overuse injuries.

### Strengths, Limitations and Future Research

The principal strength of the current research that the introduction of automated machinery for repetitive or strenuous tasks could relieve employees, especially if procedures such as REBA reveal significant risks from manual tasks. Moreover, PPE (e.g., wrist supports, back braces) may be recommended to prevent injury. The results of the assessment may highlight the need for training of workers on good ergonomic practices, such as maintaining a neutral posture or good lifting techniques. To encourage workers to report problems early, workshops on recognising signs of discomfort or strain may also be beneficial. Nonetheless, this study has certain limitations. The RULA, the REBA and the Fine Kinney are based on the judgement of the person carrying out the assessment. Different rates may score the same task differently, resulting in inconsistent results. They do not take full account of psychosocial risk factors (e.g. stress, workplace culture or workload). These factors, in ways not captured by these assessments, can have a significant impact on workers' health and performance. These methods typically provide a snapshot of ergonomic risk at one point in time. However, they may not account for changes over time. The tools are not always effective in assessing the cumulative effects of multi-tasking, which can lead to an underestimation of the risks.

Future studies may explore how the integration of psychosocial factors may provide a more holistic understanding of worker health risks. The incorporation of wearable devices such as sensors to measure posture or muscle strain and motion-capture technologies could improve the accuracy of ergonomic assessments and provide real-time data for a better assessment of risk. More insight into how ergonomic risks change and the impact of different interventions on reducing musculoskeletal disorders could be gained from long-term studies that follow the same workers over time. To enable more personalised ergonomic assessments, research could explore how individual differences such as height, strength and experience affect how workers perform certain tasks. Further research could focus on evaluating the effectiveness of the RULA/REBA/ Fine Kinney interventions, such as workplace redesign, rest or training, in reducing MSDs and improving productivity in textile and different companies.

## Conclusion

As a result, it has been observed that REBA and RULA risk analysis methods are more comprehensive in terms of applicability, functionality and working conditions in the textile sector. RULA and REBA are relatively quick to carry out and provide a rapid assessment of the level of risk. In fast-moving industries such as the textile industry, where managers need to make timely decisions, this is particularly valuable. The Fine Kinney method gives effective results in terms of risk level. In line with these results, REBA method has become the method that most clearly defines ergonomic risk factors activities in textile enterprises among the three different risk assessment methods used. High risk found by these methods are to be improved by taking corrective actions.

It was determined that the workers were carrying and lifting loads under non-ergonomic conditions. By arranging the operating environment and by making small interventions in the working postures of the workers, the workers were enabled to carry out their work in ergonomic conditions. In addition, it is envisaged that the transportation and lifting works, which are done by manpower in the enterprise, can also be done with auxiliary equipment. In this way, it is anticipated that the risk level for employees will further decrease. Employees can arrange their own work areas according to their needs. The working environment can be designed to ensure proper movement for employees. Employees can be provided with appropriate personal materials, tools, equipment or support equipment according to the job. Decreasing unnecessary movements, eliminating transport and preventing manual lifting of heavy loads can reduce the risk of discomfort through designing the workplace.

## Declaration of Interest Statement

The authors declare no conflict of interest.

## Author Contributions

Conceptualization, I.A. F.H., NA. and H.A.; methodology, I.A. F.H., NA. and H.A; software, I.A. F.H., NA. and H.A.; validation, I.A. and H.A.; formal Analysis, I I.A. F.H., NA. and H.A.; investigation, I.A. F.H., NA. and H.A; resources, I.A. F.H., NA. and H.A; data curation, I.A. F.H., NA. and H.A; writing—original draft preparation, I.A. and F.H.; writing—review and editing, I.A. F.H., NA. and H.A; I.A. F.H. and NA.; supervision, I.A. , N.A and F.H.; project administration, I.A. and N.A ;. All authors have read and agreed to the published version of the manuscript.

## Funding

This research received no external funding.

## Data Availability Statement

Data are available upon request.

## Ethics Statement

The study's protocol was approved by the ethics committee of the University Research Committee at the Yeni Yuzyil University, Istanbul, Türkiye. In accordance with the Helsinki Declaration, written informed consent was obtained from each worker before inclusion.

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