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COMPARİSON OF REBA, RULA AND OWAS ERGONOMİC RİSK ASSESSMENT METHODS: AN EXAMPLE OF A CAR TİRE BUSİNESS

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Keywords

Car Tire Worker,
Ergonomic,
OWAS,
REBA,
RULA.

Abstract

Ergonomics has an important place in the prevention of musculoskeletal disorders. In order to prevent musculoskeletal disorders, it is necessary to identify all risk factors that occur during work. This study was conducted to examine and compare the working postures of employees in an auto tire company in the Eastern Anatolia Region of Türkiye while changing tires with REBA (Rapid Entire Body Assessment), RULA (Rapid Upper Limb Assessment) and OWAS (Owako Working Position Analysis System) ergonomic risk analysis methods. The data of the study were obtained by the researcher by taking photographs of the employees and written consent of the employees was obtained. It was determined that auto tire workers exhibit seven different working postures due to their work. When the ergonomic risk assessment results of the employees for seven different working postures were analyzed, it was seen that REBA, RULA and OWAS ergonomic risk assessment methods did not give the same results. In addition, in this study, OWAS and REBA final scores were lower than RULA final scores. It is thought that this study will be a sample guide for occupational physicians, occupational safety specialists, and graduate and doctoral students working with the musculoskeletal system.

REBA, RULA VE OWAS ERGONOMİK RİSK DEĞERLENDİRME YÖNTEMLERİNİN KARŞILAŞTIRILMASI: BİR OTO LASTİK İŞLETMESİ ÖRNEĞİ

Anahtar Kelimeler

Oto Lastik Çalışanı,
Ergonomi,
OWAS,
REBA,
RULA.

Öz

Kas iskelet sistemi rahatsızlıklarının önlenmesinde ergonomi önemli yere sahiptir. Kas iskelet sistemi rahatsızlıklarından korunmak için çalışma sırasında ortaya çıkan tüm risk faktörlerini tespit etmek gerekir. Bu çalışma, Türkiye'nin Doğu Anadolu Bölgesi'nde bulunan bir oto lastik firmasında çalışanların lastik değiştirirken sergiledikleri çalışma duruşlarını REBA (Rapid Entire Body Assessment), RULA (Rapid Upper Limb Assessment) ve OWAS (Owako Working Position Analysis System) ergonomik risk analizi yöntemleri ile incelemek ve karşılaştırmak amacıyla yapılmıştır. Çalışmanın verileri araştırmacı tarafından çalışanların fotoğrafları çekilerek elde edilmiş ve çalışanların yazılı onamları alınmıştır. Oto lastik çalışanları yaptıkları iş gereği yedi farklı çalışma duruşu sergilediği tespit edilmiştir. Çalışanların yedi farklı çalışma duruşu için ergonomik risk değerlendirme sonuçları analiz edildiğinde REBA, RULA ve OWAS ergonomik risk değerlendirme yöntemlerinin aynı sonuçları vermediği görülmüştür. Ayrıca, bu çalışmada OWAS ve REBA nihai puanları RULA nihai puanlarından daha düşük çıkmıştır. Bu çalışma işyeri hekimleri, iş güvenliği uzmanları ve kas iskelet sistemi ile çalışan yüksek lisans ve doktora öğrencilerine yol gösterici kaynak niteliğinde bir örnek klavuz olacağı düşünülmektedir.

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COMPARISON OF REBA, RULA AND OWAS ERGONOMIC RISK ASSESSMENT METHODS: AN EXAMPLE OF A CAR TIRE BUSINESS

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Highlights

- Investigate the effect of different ergonomic risk analysis methods for the same working position
- Identify risk factors for musculoskeletal disorders and evaluate the impact of ergonomic changes
- Estimate appropriate ergonomic risk analysis methods in other work areas

Purpose and Scope

Workers in an automobile tire service center can cause Musculoskeletal Disorders (MSDs) due to improper work postures, as it involves handling heavy objects, such as mounting and changing tires and rims.This study was conducted to examine and compare the working postures of employees while changing tires in an auto tire company located in the Eastern Anatolia region of Türkiye with REBA (Rapid Entire Body Assessment), RULA (Rapid Upper Limb Assessment) and OWAS (Owako Working Position Analysis System) ergonomic risk analysis methods.

Design/methodology/approach

The data of the study were obtained by the researcher by taking photographs of the employees. The research is a descriptive study based on observation. This article was made to compare and discuss the internationally accepted ergonomic risk analysis methods with the internationally accepted ergonomic risk analysis methods of employees in an auto tire business.

Findings

When the results of the ergonomic risk assessment of the employees for seven different working postures were analyzed, it was found that REBA, RULA and OWAS ergonomic risk assessment methods did not give the same results. In addition, OWAS and REBA final scores were lower than RULA final scores in this study.

Research limitations/implications

Should be expanded sectorally for future studies, using ergonomic risk analysis methods in other sectors. This study is limited to employees working in an auto tire company.

Practical implications

Most importantly, which ergonomic risk analysis methods will be used in which sector should be determined by experts in the field, and training on these analyzes should be given to employers, employees, occupational safety experts and workplace physicians under the name of "ergonomic risk guide".

Social Implications

By using the correct ergonomic risk analysis method, it is ensured that employees work in a healthy and safe way, and therefore the health of employees increases productivity and contributes to both society and the national economy.

Originality

Ergonomic studies are almost non-existent in our country. therefore, ergonomic risks and analysis of auto tire workers will contribute to the literature.

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1. Introduction

Car tire service centers are considered among the most dangerous places in the automotive environment. Various car tire activities involve handling heavy objects, such as mounting and changing tires and rims. The high force and awkward postures resulting from lifting, lowering and handling tires can cause Musculoskeletal Disorders (MSD) due to improper work postures (Abd Rahman et al., 2009).

The musculoskeletal system is a complex structure of bones, joints, muscles, tendons, ligaments, nerves and blood vessels (Mishra & Sarkar, 2021). Work-related musculoskeletal diseases (WMSD) are diseases that occur with work, can increase in severity with work, and can limit the activities of the person in the work environment and outside of work (Akıncı et al., 2018). WMSD has become one of the most common health problems in society (Sirzai et al., 2015).

According to a UK study, WMSD are one of the most common occupational diseases. In the U.S., Bureau of Labor Statistics data found that WMSDs are a major component of workers' compensation, accounting for at least one-third of lost work time (Mishra & Sarkar, 2021). Preventing MSDs around the world is crucial because it has physical and economic consequences for workers, families, businesses and governments (Gómez-Galán et al., 2017).

One of the most common occupational diseases in Europe is MSDs. These occur in various parts of the body, most commonly developing in the back and upper limbs. In order to protect against MSD, it is necessary to identify all the risk factors that occur during work. Once identified, preventive measures should be taken to avoid them or measures should be taken to reduce them. Some studies suggest measures such as rotating workers between different jobs, providing ergonomics training to workers, designing ergonomic tools in the workplace and ergonomically redesigning the work equipment used (Gómez-Galán et al., 2020).

In addition, ergonomics has an important place in preventing MSDs. Ergonomics is a field of science that examines human-machine-environment properties and the relationship between these properties. In terms of meaning, ergonomics is formed from the Greek words ergos meaning work and nomos meaning science (Yaşar & Saraçoğlu, 2021). The aim of ergonomics is to make a work system work better by improving the interactions between users and machines (Bridger, 2008).

In Türkiye, there is no structured systematic ergonomic risk assessment approach used by businesses to assess and monitor work-related MSDs. This deficiency causes occupational safety specialists working in workplaces to hesitate and have difficulties in observation, analysis and interpretation stages, including method selection (Felekoğlu & Taşan, 2017).

The aim of this study is to examine the working postures of employees in a tire company located in the eastern Anatolia region of Türkiye and to evaluate the ergonomics of OWAS (Owako Working Position Analysis System), REBA (Rapid Entire Body Assessment) and RULA (Rapid Upper Limb Assessment), whose reliability has been proven in the literature is to compare these methods using risk analysis methods.

2. Materials and Methods

The methods used in the evaluation of MSDs vary depending on factors such as countries, workplaces and working environment (Hita-Gutiérrez et al., 2020). Looking at the literature, risk assessment tools for musculoskeletal disorders are grouped into three categories: self-assessment tools (surveys), observation tools and direct measurement tools (David, 2005; Gómez-Galán et al., 2020; Gómez-Galán et al., 2017; Norval et al., 2018). Risk assessment tools for musculoskeletal disorders are listed in Table 1.

Table 1. Risk assessment tools for MSDs

Self-Assessment Tools	Observation Tools	Direct Measurement Tools
Employing questionnaires	Observing the task being carried out and using software to analyse it	Placing sensors on employees' bodies while performing tasks

Observational methods are the most commonly used tools to identify risk factors for MSDs in the workplace and to evaluate the impact of ergonomic changes (Oliv et al., 2019). It is based on direct observation of employees as they perform their duties. Practitioners collect necessary data while observing the work performed by the worker. After this, they use tables or equations to quantify risks related to ergonomic aspects of the tasks developed

(Diego-Mas et al., 2017). Additionally, they are relatively easy to use, require a lower level of expertise than other techniques, and do not require complex calibration procedures (Diego-Mas et al., 2017; Diego-Mas et al., 2015). For these reasons, observational methods appear better adapted to the needs of practitioners who often have limited resources and time and need techniques that allow them to determine priorities for intervention (Diego-Mas et al., 2017). Table 2 includes the classification of observational methods.

Table 2. Classification of observational methods (Gómez-Galán et al., 2020; Gómez-Galán et al., 2017)

Handling of Loads	Repeatıtıve Movements	Straıned Postures
KIM Method	RULA Method	REBA Method
INSHT Method	"Work Strain Index" Method	PATH Method
MAC Method	OCRA Method	OWAS Method
SNOOK and CIRIELLO Tables	Stop and Repetition Risk Factor Index (PRRI)	CORLETT Method
LIBERTY MUTUAL Tables	PLIBEL Method	YOL Method
NIOSH Method	IBV Method	Vıra Method

Many studies have investigated work risks using ergonomic risk assessment tools to prevent MSDs. The most common assessment tools include REBA, RULA and OWAS (Kong et al., 2018). The main reason for using REBA, RULA and OWAS methods together in this study is to comprehensively analyze ergonomic risks in the workplace at both general and regional levels. The REBA method provides a general risk analysis by evaluating all body positions and reveals risks especially in the spine, neck, trunk and lower extremities. RULA focuses on assessing risks to the arms, hands and wrists by examining upper limb movements in detail. OWAS offers a more systematic analysis of working postures by identifying overall workload and risk classes. Using these methods together has enabled a multidimensional analysis to cover all body risks in the workplace, rather than focusing only on a specific region.

2.1. REBA, RULA and OWAS Methods

RULA, REBA and OWAS are widely used in the industrial sector as ergonomic risk assessment tools to analyze various tasks. However, each assessment tool has a different purpose and development history, so risk assessment varies depending on the type of task analyzed (Choi et al., 2020).

RULA and REBA are two easy methods for occupational postural risk assessment. Both RULA and REBA allow to obtain a numerical index that represents the quantitative value of the risk exposed to the employee during the targeted work activity and to derive the priority level of the intervention and the required actions. The RULA method is recommended for detecting posture disorders in the upper extremities, neck and back depending on muscle movement and external loads applied to the body. The REBA method is applied to determine posture disorders of the whole body regarding muscle movement. RULA and REBA methods are stated among the methods chosen for the prevention of Work-Related MSDs according to the International Ergonomics Association (IEA) and the World Health Organization (WHO) (Micheletti Cremasco et al., 2019). The RULA method can be considered an advanced form of the OWAS method used for closer examination of the upper extremity (Yazdanirad et al., 2018).

2.1.1 REBA (Rapid Entire Body Assessment)

REBA is a method specifically designed to analyze whole body postures, strength, load, which are most suitable for standing work, determining the lower limbs, upper limbs, trunk, neck and other activity factors (Hignett & McAtamney, 2000; Marak et al., 2020). The difference of the REBA method from other evaluation methods such as RULA and OWAS is that it takes the employee's lower extremities into consideration (Hita-Gutiérrez et al., 2020). REBA method is a risk analysis method that varies according to the working postures of the employee's entire body during work and the weight of the load he is exposed to during this time. When the REBA analysis method is applied to the employee, a score ranging from 1 to 15 is obtained.

In the REBA method, the body is scored by dividing it into two groups, A and B. Figure 1 shows the scoring system for group A (trunk, neck and legs). Strength/Load Score is added after neck, trunk and leg analyses. If the weight of the workpiece or material is less than 5 kg, 0 points are added, if the weight is between 5 kg and 10 kg, +1 point is added, and if the weight is more than 10 kg, +2 points are added. If there is a sudden and rapid increase in strength in addition to weight, +1 additional point should be added to find the Strength/Load score.

Figure 1 shows the scoring system for group B (upper arm, lower arm and wrist). Grip Score is added after analyzing the upper arm, lower arm and wrist. If the workpiece is grasped well, 0 points should be added, if there is a moderate grasp, +1 point, if there is a poor grasp, +2 points, and if the grip is inappropriate in any way, +3

points should be added to obtain the grip score. After A and B scores are calculated, they are marked in the C matrix in figure 1 and C score is obtained. After the C score is calculated from the matrix table, the REBA risk score is calculated by calculating the activity score.

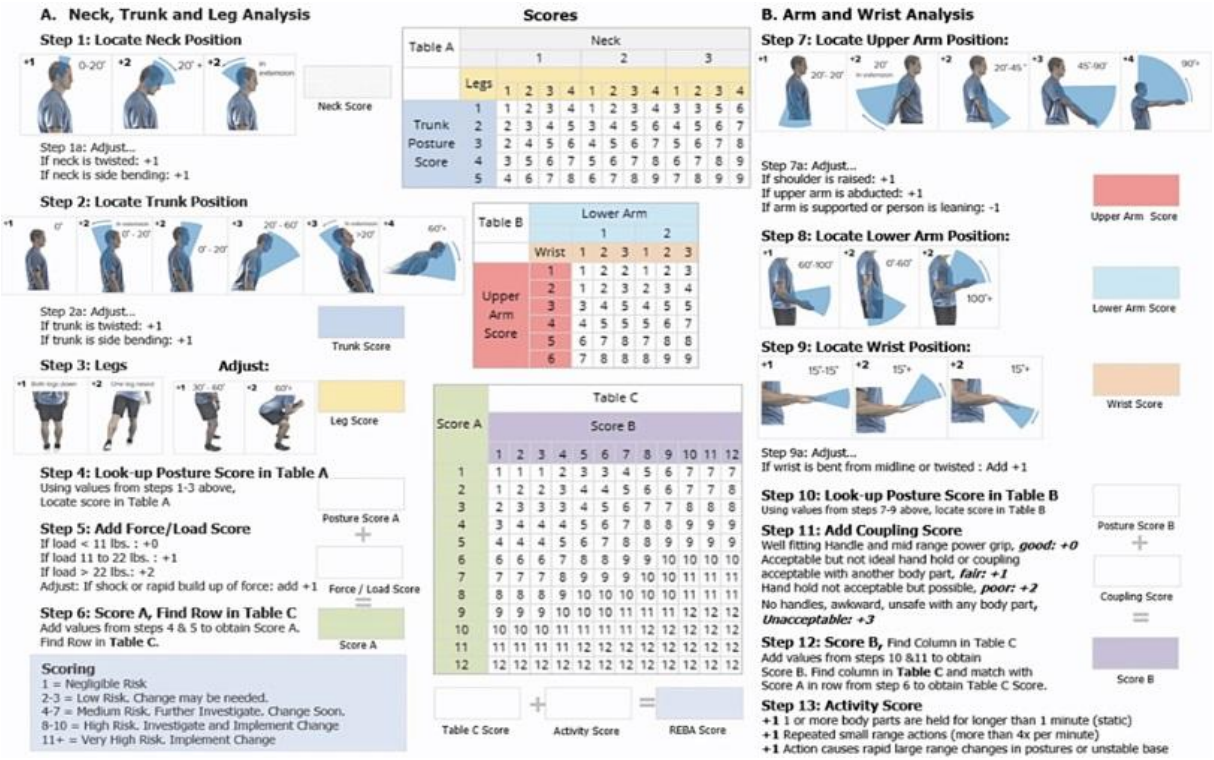

Figure 1. REBA scoring algorithm (Morrison et al., 2024)

Interpretation of the total REBA score is made as in Table 3.

Table 3. REBA action levels (Hignett & McAtamney, 2000).

Action Level	REBA Score	Risk Level
0	1	Negligible
1	2-3	Low risk
2	4-7	Medium risk
3	8-10	High risk
4	11-15	Very high risk

2.1.2. RULA (Rapid Upper Limb Assessment)

The RULA method, developed by Corlett and McAtamney (1993), is a method that allows the rapid assessment of strains in the employee's neck, trunk, upper arms, hands and legs. According to the RULA method, body parts in a working posture are divided into groups A (Upper Arm, Lower Arm and Wrists) and B (Neck, Trunk and Legs). As seen in Figure 2, the RULA method, which consists of a total of 15 steps, is an analysis method that determines whether the employee has a risky working posture or not by determining the total RULA score (McAtamney & Corlett, 1993; Namwongsa et al., 2018).

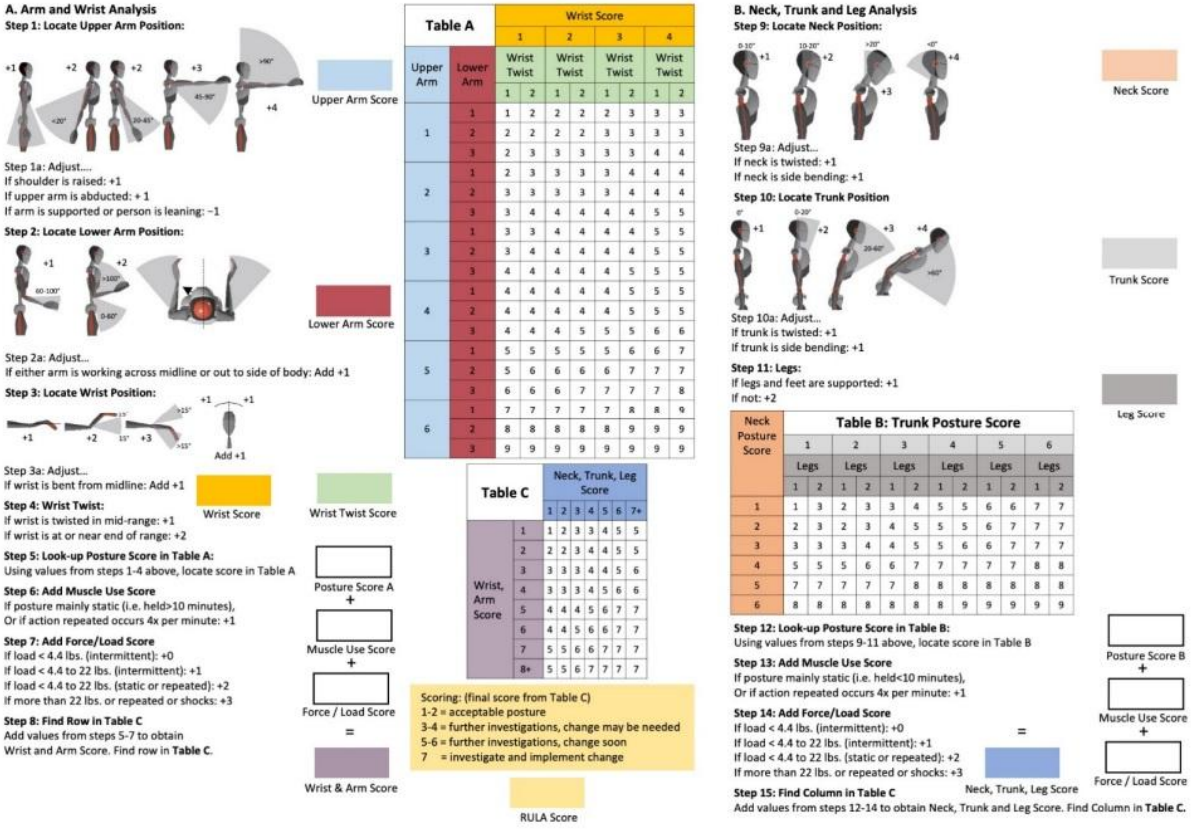

Figure 2. RULA scoring algorithm (Maurer-Grubinger et al., 2021).

Interpretation of the total RULA score is made as in Table 4.

Table 4. RULA action levels (Maurer-Grubinger et al., 2021).

Action Level	RULA Score	Risk Level
1	1-2	Low risk
2	3-4	Medium risk
3	5-6	High risk
4	7	Very high risk

2.1.3. OWAS (Owako Working Position Analysis System)

OWAS is a widely used observational assessment method to determine risk for WMSDs (Lins et al., 2021). It was developed by Karhu et al in 1977 (Karhu et al., 1977). In OWAS, worker postures are evaluated by the assessor in three or four categories (arms, legs, back, and sometimes load), usually between 30 seconds and 5 minutes. The OWAS method is a relatively simple assessment method and can therefore be applied by people without explicit training in ergonomics (Lins et al., 2021).

The OWAS classification system divides working posture into three categories: back, arms and legs (Lins et al., 2021). There are four working postures for the back, three for the arms and seven for the legs. It also defines three categories for the weight of the load carried or the amount of force used (Kee, 2022). The observer selects the working posture that is closest to the employee's actual posture and the numerical value corresponding to that posture is given. Numerical values corresponding to back, arms, legs and load/power usage form a four-digit code that defines posture (Lins et al., 2021). Figure 3 shows the OWAS method working posture and load/power usage numerical values and coding structure (Özoğul et al., 2018).

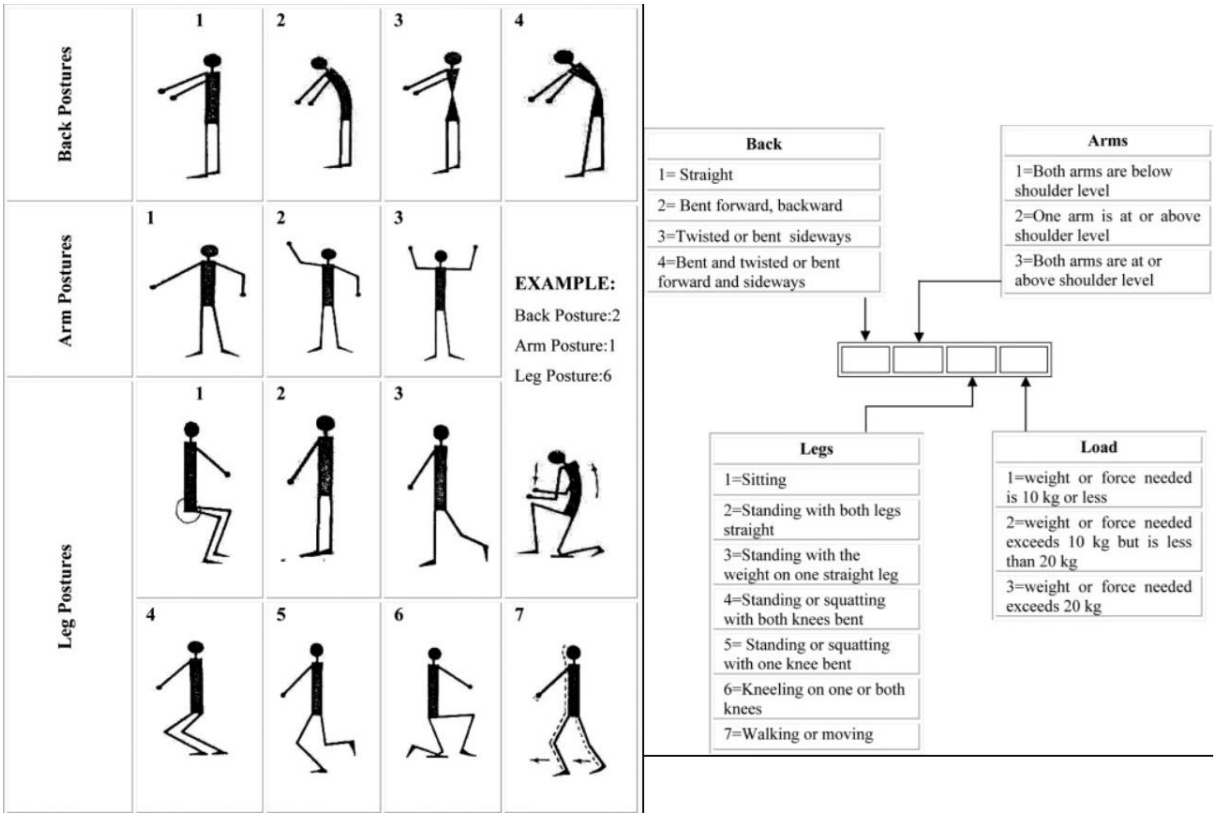

Figure 3: OWAS method working postures and coding structure (Fığlalı et al., 2015).

Figure 4 is used to determine the common impact of the four defined codes on employees and to decide whether improvements should be made.

			Bacaklar																				
			1			2			3			4			5			6			7		
			Kuvvet			Kuvvet			Kuvvet			Kuvvet			Kuvvet			Kuvvet			Kuvvet		
		Kollar	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Sırt	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	1	1	1	1	1	1
		2	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	1	1	1	1	1	1
		3	1	1	1	1	1	1	1	1	1	2	2	3	2	2	3	1	1	1	1	1	2
	2	1	2	2	3	2	2	3	2	2	3	3	3	3	3	3	3	2	2	2	2	3	3
		2	2	2	3	2	2	3	2	3	3	3	4	4	3	4	4	3	3	4	2	3	4
		3	3	3	4	2	2	3	3	3	3	3	4	4	4	4	4	4	4	4	2	3	3
	3	1	1	1	1	1	1	1	1	1	2	3	3	3	4	4	4	1	1	1	1	1	1
		2	2	2	3	1	1	1	1	1	2	4	4	4	4	4	4	3	3	3	1	1	1
		3	2	2	3	1	1	1	2	3	3	4	4	4	4	4	4	4	4	4	1	1	1
	4	1	2	3	3	2	2	3	2	2	3	4	4	4	4	4	4	4	4	4	2	3	4
		2	3	3	4	2	3	4	3	3	4	4	4	4	4	4	4	4	4	4	2	3	4
		3	4	4	4	2	3	4	3	3	4	4	4	4	4	4	4	4	4	4	2	3	4

Figure 4. OWAS action levels

In Figure 4, four different action categories can be determined as a result of stance-force combinations. These action classes are given below

- Action category 1: normal postures that do not require any special attention
- Action category 2: postures must be taken into account during the next regular check of working methods
- Action category 3: postures need to be considered in the near future
- Action category 4: postures need to be evaluated immediately (Kee, 2022).

2.2. Implementation of the Research

This study was carried out between 15 and 25 October 2023 in a tire company located in the Eastern Anatolia region of Türkiye. Auto tire workers exhibit 7 different working postures when changing car tires. Figure 5 shows the movements he makes while placing the jack under the car.

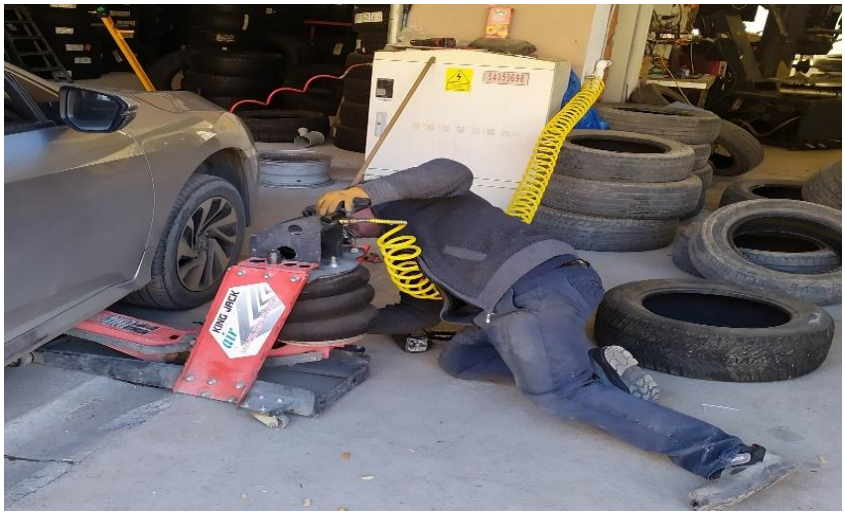

Figure 5. First working posture

Figure 6 shows the movements he makes while removing the tire from the car. Since the working postures when removing and installing the tire from the car involve the same movements, the analysis of the working posture while installing the tire was not performed.

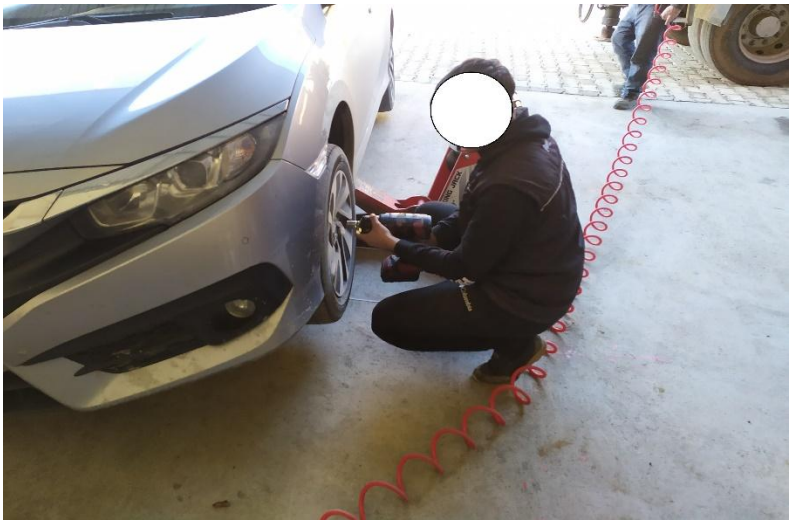

Figure 6. Second working posture

Figure 7 shows the working movements of the employee while separating the tire from the rim. The worker exhibits three different working postures when separating the tire from the rim. The first working stop is to deflate the tire (A), the second working stop is to separate the tire from the rim (B), and the third work stop is to completely remove the tire from the rim (C).

Figure 7. Third working posture

Figure 8 shows the working postures he made while opening the tire tread (A) and the working postures he made while repairing the tire (B).

Figure 8. Fourth working posture

In the figures above, visuals are given about the work done by employees in the tire company. In this context, the ergonomic risk analyzes of the employees while repairing a tire were analyzed with REBA, RULA and OWAS methods and their action levels were compared.

2.3. Ethics Statement

This study was approved by the Scientific Research Ethics Committee of a university in Türkiye (Date: 14.09.2023 Decision No: E-18457941-050.99-104667). Permission was obtained from the tire company where the research was conducted. The employees were informed about the purpose and process of the study and their written permission was obtained.

3. Results

REBA, RULA and OWAS final scores, action levels and risk levels of tire workers' working postures are given in the tables below.

Table 6. REBA, RULA and OWAS final scores of working postures

	REBA	**RULA**	**OWAS**
First Working stance	10 points	6 points	4 points
Second Working stance	5 points	6 points	2 points
Third Working stance - A	3 points	7 points	2 points
Third Working stance - B	6 points	7 points	2 points
Third Working stance - C	2 points	6 points	1 points
Fourth Working stance - A	9 points	7 points	2 points
Fourth Working stance - B	3 points	7 points	2 points

In the ergonomic risk assessment of the work performed by the tire worker, it was determined that the highest REBA score (10 points) was the first working posture, followed by the fourth working posture-A (9 points) and the third working posture-B (6 points). When looking at the RULA score of the working postures, the highest score is in the third working posture - A/B (7 points) and in the fourth working posture - A/B (7 points), followed by the first working posture (6 points), the second working posture (6 points) and the third working posture (6 points). It is seen that the working posture follows -C (6 points). When looking at the OWAS score of working postures, it is seen that the highest working posture is the first working posture (4 points), followed by the second working posture (2 points), the third working posture - A/B (2 points) and the fourth working posture - A/B (2 points). It is seen that it follows (Table 6).

Table 7. REBA, RULA and OWAS action levels of working postures

	REBA	**RULA**	**OWAS**
First Working stance	Action level 3	Action level 3	Action level 4
Second Working stance	Action level 2	Action level 3	Action level 2
Third Working stance - A	Action level 1	Action level 4	Action level 2
Third Working stance - B	Action level 2	Action level 4	Action level 2
Third Working stance - C	Action level 1	Action level 3	Action level 1
Fourth Working stance - A	Action level 3	Action level 4	Action level 2
Fourth Working stance - B	Action level 1	Action level 4	Action level 2

Looking at the REBA action levels of the working postures in Table 7, it was determined that the highest REBA action level was the first working posture and the fourth working posture-A (Action level 3), followed by the second working posture and the third working posture-B (Action level 2). Considering the RULA action levels, the highest action level is in the third working posture-A/B and the fourth working posture-A/B (Action level 4), followed by the first working posture, the second working posture and the third working posture-C (Action level 3). can be seen. When looking at the OWAS action levels, it is seen that the highest action level is the first working stance (Action level 4), followed by the second working stance, the third working stance-A/B and the fourth working stance-A/B (Action level 2).

Table 8. REBA, RULA and OWAS risk levels of working postures

	REBA	**RULA**	**OWAS**
First Working stance	High risk	High risk	Very high risk
Second Working stance	Medium risk	High risk	Medium risk
Third Working stance - A	Low risk	Very high risk	Medium risk
Third Working stance - B	Medium risk	Very high risk	Medium risk
Third Working stance - C	Low risk	High risk	Low risk
Fourth Working stance - A	High risk	Very high risk	Medium risk
Fourth Working stance - B	Low risk	Very high risk	Medium risk

Looking at the REBA risk levels of the working postures in Table 8, the first working posture and the fourth working posture - A is the second working posture where A is high risk working posture and the third working posture is A/C where the third working posture is medium risk working posture and the fourth working posture is A/C and the fourth working posture is B has been found to be a low-risk working posture. When looking at the RULA risk levels of the working postures, it was determined that the third working posture - A/B and the fourth working posture - A/B exhibited a very high risk working posture, while the first working posture, the second working posture and the third working posture - C exhibited a high risk working posture. When the OWAS risk levels of the working postures were analyzed, it was found that the first working posture was a very high-risk working posture, the second working posture was a medium-risk working posture, the third working posture-A/B and the fourth working posture-A/B exhibited a medium-risk working posture, and the third working posture-C exhibited a low-risk working posture.

4. Result and Discussion

In this study, the ergonomic risks encountered in the workplace were evaluated in detail by using REBA, RULA and OWAS methods together. The combination of the methods allowed us to comprehensively analyze the risks in different body parts. However, certain limitations of the methods used must also be taken into account. For example, REBA and RULA focus on static postures, while lacking the continuous analysis of dynamic movements. Similarly, although the OWAS method provides general workload and posture analysis, it cannot assess detailed loads on the musculoskeletal system. These limitations suggest that the results of the study are generalizable only for static and semi-dynamic work processes. Nevertheless, the combination of the methods increased the accuracy and reliability of the results and provided a comprehensive framework for identifying the risks of musculoskeletal disorders.

When we look at the ergonomic risk assessment results made with REBA, RULA and OWAS methods, the riskiest working posture for REBA is the movements it makes while placing the jack under the car and the working posture it makes while opening the tire thread, while the most risky working posture for RULA is the movements it makes while deflating the tire and the movements it makes while separating the tire from the rim. It can be seen that there are movements, the movements he makes while opening the tire tread, and the movements he makes while repairing the tire. For OWAS, the riskiest working posture seems to be the movements made while placing a jack under the car.

While the lowest risk working postures for REBA are the movements made while deflating the tire, completely removing the tire from the rim and repairing the tire, the lowest risk working postures for RULA have not been determined. For OWAS, it was concluded that the movement to completely remove the tire from the rim was the working posture with the lowest risk.

Looking at the results of three different ergonomic risk assessments, it is seen that only the movements made while opening the tire tread give the same result for REBA and RULA. It can be seen that for REBA and OWAS, the movements when placing a jack under the car give the same result. In addition, the movements made to completely remove the tire from the rim were found to be the lowest risk of the two methods and were determined to have parallel results. No common results were found for RULA and OWAS.

In this context, when the ergonomic risk assessment results for seven different working postures are examined, it is concluded that REBA, RULA and OWAS ergonomic risk assessment methods do not give the same results. However, if this study had been conducted for a single working posture, it would be possible to comment that three different ergonomic risk analysis methods gave the same results. When we look at the REBA, RULA and OWAS ergonomic risk assessment final scores of the movements he made while placing a jack under the car, which was his first working posture (Table 9), we see that his REBA score was 10 points and he exhibited a high-risk working posture, and his RULA score was 6 points and he exhibited a high-risk working posture. It is seen that the OWAS score is 4 points and exhibits a very high risk working posture.

Table 9. First working posture REBA, RULA and OWAS scores

	final score	**Action level**	**Risk level**
REBA	10 point	Action level 3	High risk
RULA	6 point	Action level 3	High risk
OWAS	4 point	Action level 3	High risk

Looking at Table 9, it can be seen that the REBA, RULA and OWAS results of the working postures made by the employee while placing the jack under the car give parallel results. In other words, it is understood that all ergonomic risk action levels are high and regulations need to be made in the short term.

In this study, it was determined that although three different ergonomic risk assessment methods seem to give similar results for a single working posture, they do not give the same results for all working postures. When looking at the literature, there are very few studies comparing REBA, RULA and OWAS. Lee et al. compared the three most commonly used tools, OWAS, RULA and REBA, and analyzed the characteristics from working posture loads. They found that waist postures played an important role in determining the overall load level in the OWAS compared to shoulder postures, while the RULA did not adequately discriminate lower limb postures and the REBA was more suitable for assessing whole-body working postures than the other assessment tools (Lee et al., 2003).

The results of a study by Kee and Karwowski (2007) showed that the RULA predicted 56% of the risk of musculoskeletal disorders in moderate and high occupations, while the OWAS and REBA predicted 79% of the risk of musculoskeletal disorders in low and very low levels in the same occupations (Kee & Karwowski, 2007).

Sanchez et al. (2013) also showed that the RULA method does not have sufficient power to predict low risks, especially since RULA does not categorize any operation as low risk (Sanchez-Lite et al., 2013). In the analysis conducted by Yaylı and Çalışkan (2019) using REBA, RULA and OWAS methods to analyze working postures related to forest sapling works, 4.6% of employees were found to be risky according to OWAS, 8% according to REBA and 20% according to RULA method (Yayli and Caliskan 2019). The fact that the RULA method was found to be the most risky supports our study.

In an experimental study conducted with fifteen university students using REBA, RULA and OWAS methods, Kee (2020) reported that, regardless of the nature of the job, the type of work and whether the body postures are balanced, OWAS and REBA generally affected the postural loads for the analyzed postures according to RULA. He found that he underestimated (Kee, 2020). In our study, OWAS and REBA scores were lower than RULA, and this result supports our study in the literature.

Joshi and Deshpande (2021) found that OWAS may be more appropriate for assessing risk if the load/power utilization is less than 5 kg, while REBA and RULA may be more appropriate for load ranges of 5 kg - 10 kg and loads greater than 10 kg, respectively (Joshi & Deshpande, 2022).

In a study comparing REBA, RULA and OWAS methods based on the literature, Kee (2022) stated that, although it has an important limitation of containing only two classifications for leg postures, RULA is the most frequently used method among the three techniques, and in many studies, it is used for unbalanced lower extremity postures. It was determined that RULA was used even in the evaluation and studies conducted with RULA evaluated postural loads as higher risk levels (Kee, 2022). In our study, low risk level working posture for RULA was not detected and it supports Kee's study.

In this study, which examined the ergonomic risks of auto tire workers for seven different working postures, it is recommended that the working surface should be adjusted and ergonomic equipment should be used for working postures with high REBA scores, repetitive movements should be reduced and regular rest breaks should be planned for working postures with high RULA scores, and workstations should be rearranged to support postures to improve general working postures when OWAS scores are high.

The number of studies on ergonomic risks in Türkiye is quite low. For this reason, it is inevitable that employees will be exposed to musculoskeletal disorders and therefore their health expenses will become a burden on the country's economy. Ergonomic risks should be evaluated in all businesses, regardless of the number of employees. Ergonomic aspects of the equipment, equipment and tools used should be examined by technical experts. Training on ergonomic working postures should be planned and given. Visual designs and brochures regarding ergonomics should be presented. Most importantly, which ergonomic risk analysis methods will be used in which sector should be determined by experts in the field, and training on these analyzes should be given to employers, employees, occupational safety experts and workplace physicians under the name of "ergonomic risk guide".

Conflicts of Interest

Author declared no known conflicts of interest associated with this study.

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