Jurnal Polimesin
Department of Mechanical Engineering
State Polytechnic of Lhokseumawe
http://e-jurnal.pnl.ac.id/polimesin

e-ISSN	: 2549-1999	No.	: 5	Month	: October
p-ISSN	: 1693-5462	Volume	: 23	Year	: 2025

Processing dates: received on 2025-06-17, reviewed on 2025-07-05, accepted on 2025-09-24 and online availability on 2025-10-31

Analysis of working posture of coffee bean milling operators to reduce musculoskeletal disorder risks using the OWAS and REBA method

Mutia[1], Mohd Iqbal[2*], Iskandar Hasanuddin[2]

[1]Master of Industrial Engineering, Universitas Syiah Kuala, Banda Aceh 23111, Indonesia
[2]Department of Mechanical and Industrial Engineering, Universitas Syiah Kuala, Banda Aceh 23111, Indonesia
*Corresponding author: mohd.iqbal@usk.ac.id

Abstract

Repetitive work involving lifting heavy loads over long distances and non-ergonomic working postures can lead to musculoskeletal disorders (MSDs). This problem is commonly found in coffee factories, particularly during the coffee bean grinding process, where two main activities are performed: the first is taking coffee beans from the ground, and the second is lifting the coffee beans to the grinding machine. The task of taking coffee beans from the ground involves a bent posture to collect them from a non-ergonomic coffee storage box. Meanwhile, in the task of lifting the beans to the grinding machine, workers must carry 25 kg of coffee over a distance of 8 meters. The purpose of this study was to evaluate work posture using the Ovako Working Posture Analysis System (OWAS) and Rapid Entire Body Assessment (REBA) methods. Six operators were observed at the coffee bean grinding station. The results show that three operators who perform the task of collecting beans from the ground received a category 3 score using the OWAS method, indicating that corrective action should be taken as soon as possible. In the task of lifting beans to the grinding machine, three operators received a score of 4 according to the OWAS method, also indicating that immediate corrective action is necessary. Based on the REBA method, three operators scored 10, classified as a high-risk level (action level 3), while the other three scored 11, indicating a very high-risk level. Based on these findings, it is necessary to provide ergonomic coffee storage boxes that accommodate workers' posture in coffee factories and are easy to move according to the workers' needs, to reduce the risk of musculoskeletal disorders.

Keywords:
Ergonomics, working posture, OWAS, REBA, musculoskeletal disorders (MSDs)

1 Introduction

Musculoskeletal disorders (MSDs) are one of the most common occupational health problems experienced by workers in the industrial sector. MSDs can cause complaints in muscles, joints, ligaments, and soft tissues that arise due to excessive workload or incorrect body posture over a long period [1].

The high incidence of MSDs in the informal sector indicates a lack of application of ergonomic principles in work design. In the coffee processing industry, workers in the coffee bean grinding section are at high risk of developing this disorder due to repetitive and non-ergonomic work activities.

Activities such as bending to take coffee beans from storage and lifting a load of 25 kg to the grinding machine as far as 4-8 meters are carried out repeatedly without the aid of ergonomic tools. This not only reduces work productivity but also increases the risk of long-term injury.

Previous studies by Munanda et al. [2] and Iqbal et al. [3], [4] have shown that work posture analysis using ergonomic methods can be effective in identifying risks and providing recommendations for improvement. Spalanzani's study [5] also shows that the use of the OWAS method combined with anthropometric data can improve work facility design to reduce the risk of MSDs.

However, there is still limited research that focuses on the coffee processing industry in Bireuen Regency, especially on coffee bean grinding workers at Indaco and Arasco factories that have similar manual work characteristics but with technical differences in lifting activities. Therefore, this study is necessary to analyze the work posture of coffee bean grinding operators and provide recommendations for improving work facilities based on worker anthropometric data to reduce the risk of MSDs and improve work efficiency. This study aims to analyze the work posture of coffee bean grinding operators using the OWAS and REBA methods and provide recommendations for improving work facilities based on worker anthropometry.

2 Method

2.1 Ovaco working posture analysis system

OWAS is an ergonomic method used to evaluate postural stress in workers that can lead to musculoskeletal disorders. Developed in the 1970s at the Finnish Ovako Oy company, this method was created by Karhu and his team at the Finnish Labor Health Laboratory, who studied the impact of work posture on health issues such as back, neck, shoulder, and leg pain.

The OWAS method codes work postures based on the back, hands, feet, and load weight, with each part having its own classification. This method quickly identifies work postures that pose a risk of musculoskeletal disorders. The OWAS posture code consists of four digits, representing the back, arms, legs, and load weight, in sequence, specifically for manual material handling [5], [6].

2.2 Rapid entire body assessment

Rapid Entire Body Assessment (REBA) is an ergonomic method used to quickly assess the posture of a worker's neck, back, arms, wrists, and legs. This posture analyzer tool evaluates worker activity, taking into account coupling factors, external loads, and work activities.

REBA was developed to detect and address risky work postures promptly, without requiring specialized equipment. This approach enables researchers to be trained in conducting assessments and measurements without incurring additional costs or needing extra equipment, and REBA assessments can be performed in confined spaces without disrupting workers. The REBA method categorizes body segments into two groups: Group A, comprising the back (torso), neck, and legs, and Group B, consisting of the upper arms, lower arms, and wrists. To determine the REBA score, which indicates the risk level of work postures, the following steps are taken: (1) calculate the A score for Group A postures plus the load score, and the B score for Group B postures plus the coupling score; (2) use both scores to determine the C score; and (3) add the activity score to the C score to obtain the final REBA score, which can then be used to determine the level of injury risk [7], [8], [9], [10].

2.3 Anthropometry

Anthropometry, derived from the Greek words 'anthro' meaning human and 'metri' meaning measurement, is the study of human body dimensions. Anthropometry plays a crucial role in ergonomics, informing the design of products and work systems that require human interaction. Humans generally differ in terms of the shape and dimensions of their body size [11], [12], [13].

2.4 Type of research

This research is a quantitative descriptive study with a case study approach. The purpose of this study is to describe the working posture of workers at the coffee bean grinding station in two industrial locations, namely Indaco and Arasco factories. The focus of observation is on two main activities, namely taking coffee beans from storage and lifting them to the grinding machine.

2.5 Data collection techniques

This study employs several data collection techniques, namely:

a. Direct Observation: Conducting direct observations in the field to record the required data related to the research object.
b. Interviews: Conducting interviews with factory management and workers to obtain relevant information and supplement the data obtained from observations.
c. Documentation Study: Collecting data by recording factory documentation that is directly related to the research.
d. Literature Study: Reviewing concepts and theories from relevant books and journals to support the completion of the research.
e. Questionnaire: Distributing the Standard Nordic Questionnaire (SNQ) to workers at Indaco and Arasco to obtain data on musculoskeletal complaints and work comfort.

2.6 Rationale for selecting OWAS and REBA methods

The OWAS method was chosen for its ability to identify work posture strain based on the combination of back, arm, leg, and load positions. This method is particularly suitable for manual physical activities such as bending, standing, and lifting loads, which are common among coffee bean grinding operators. Meanwhile, the REBA method was used for its detailed evaluation of overall body posture, including the neck, back, wrists, and lower extremities. The REBA method is well-suited for dynamic work situations with repetitive activities and heavy loads.

2.7 Anthropometric data of workers

Anthropometric data of workers were collected through direct measurements of workers at Indaco and Arasco, located in Jeumpa District, Bireun Regency. The anthropometric data can be seen in Table 1:

Table 1. Anthropometric Measurement Data of Workers at Indaco and Arasco

No	Operator	SHE (cm)	FAR (cm)	SH (cm)	HGH (cm)
1	Gilang	113	85	50	110
2	Junaidi	103	78	46	95
3	Amad	106	80	47	100
4	Saiful	110	82	48	105
5	Riki	100	75	45	90
6	Ibrahim	116	87	52	110

Body Dimension Description:
Standing Elbow Height = SHE
Forward Arm Reach = FAR
Shoulder Width = SH
Hand Grip Height = HGH

3 Work posture assessment using OWAS and REBA methods

This study focuses on the work postures of operators in the coffee bean grinding process, which involves two main activities: retrieving coffee beans for grinding and lifting them to the grinding machine.

To assess the ergonomic risks associated with these activities, measurements were taken of operators in the coffee factory using the Ovaco Working Posture Analysis System (OWAS) and Rapid Entire Body Assessment (REBA) methods.

1. Operator 1
   Figure 1 illustrates the activity of Operator 1 carrying coffee beans to be ground, with his back bent at 550, both arms positioned below shoulder level, feet standing flat on the ground with bent knees, while lifting a load of 25 kg.

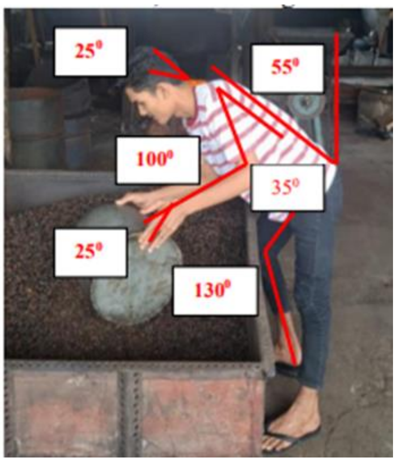

Fig. 1. Activity of taking coffee beans to be ground by operator 1

2. Operator 2
   Figure 2 illustrates the activity of Operator 2 carrying coffee beans to be ground, with his back bent at 60^0, both arms positioned below shoulder level, feet standing flat on the ground with bent knees, while lifting a load of 25 kg.

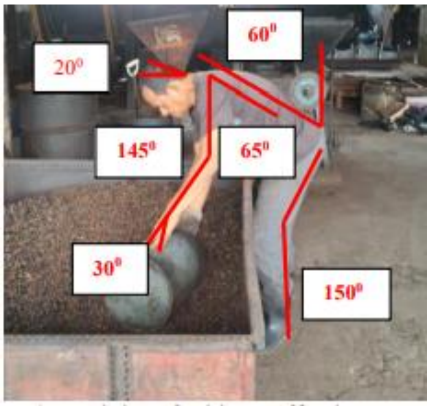

Fig. 2. Activity of taking coffee beans to be ground by operator 2

3. Operator 3
   Figure 3 illustrates the activity of Operator 3 carrying coffee beans to be ground, with his back bent at 90^0, both arms positioned below shoulder level, feet standing flat on the ground with bent knees, while lifting a load of 25 kg.

Fig. 3. Activity of taking coffee beans to be ground by operator 3

4. Operator 4
   Figure 4 illustrates the activity of Operator 4 lifting coffee beans to the grinding machine, with his back bent at 20^0, both

arms positioned above shoulder level, and a stance involving walking up stairs while lifting a 25 kg load of coffee beans.

Fig. 4. Activity of lifting coffee beans to the grinding machine by operator 4

5. Operator 5
   Figure 5 illustrates the activity of Operator 5 lifting coffee beans to the grinding machine, with his back bent at 25^{0}, both arms positioned above shoulder level, and a stance involving walking up stairs while lifting a 25 kg load of coffee beans.

Fig. 5. Activity of lifting coffee beans to the grinding machine by operator 5

Fig. 6. Activity of lifting coffee beans to the grinding machine by operator 6

6. Operator 6
   Figure 6 illustrates the activity of Operator 6 lifting coffee beans to the grinding machine, with his back bent at 25^{0}, both arms positioned above shoulder level, and a stance involving walking up stairs while lifting a 25 kg load of coffee beans.

The recapitulation of the work posture calculation results for coffee bean milling operators based on the OWAS and REBA methods can be seen in Tables 2 and 3

Table 2. Recapitulation of Work Posture Calculation Results for Coffee Bean Milling Operators Based on the OWAS Method

No	Work Posture	Final Score	Action
1	Operator 1: Taking coffee beans for grinding	3	Corrective action should be taken as soon as possible
2	Operator 2: Taking coffee beans for grinding	3	Corrective action should be taken as soon as possible
3	Operator 3: Taking coffee beans for grinding	3	Corrective action should be taken as soon as possible
4	Operator 4: Lifting coffee beans to the machine	4	Immediate action is required.
5	Operator 5: Lifting coffee beans to the machine	4	Immediate action is required
6	Operator 6: Lifting coffee beans to the machine	4	Immediate action is required

Based on the OWAS category assessment results summarized in Table 1, it is evident that the working postures of the first, second, and third operators, who are involved in transporting coffee beans to the grinding machine, fall into category 3. This classification indicates that the working conditions require corrective action as soon as possible. In contrast, the working postures of the fourth, fifth, and sixth operators, who are engaged in lifting coffee beans to the grinding machine, are categorized as 4, signifying that immediate corrective measures are necessary.

Table 3. Recapitulation of Work Posture Calculation Results for Coffee Bean Milling Operators Based on the REBA Method.

No	Work Posture	Grand Score	Action Level	Risk Level	Action
1	Operator 1: Taking coffee beans for grinding	10	3	High	Corrective action is required
2	Operator 2: Taking coffee beans for grinding	10	3	High	Corrective action is required
3	Operator 3: Taking coffee beans for grinding	10	3	High	Corrective action is required
4	Operator 4: Lifting coffee beans to the machine	11	4	Very High	Immediate action is required
5	Operator 5: Lifting coffee beans to the machine	11	4	Very High	Immediate action is required
6	Operator 6: Lifting coffee beans to the machine	11	4	Very High	Immediate action is required

Based on the REBA category assessment results summarized in Table 2, the working postures of the first, second, and third operators, who are involved in lifting coffee beans to the grinding machine, result in a final score of 3, classified as high risk. This classification suggests that immediate corrective measures are necessary to address the working conditions. Furthermore, the working postures of the fourth, fifth, and sixth operators, who lift coffee beans to the grinding machine, yield a final score of 4, categorized as very high risk, necessitating immediate attention and corrective action.

4 The calculation of worker anthropometric dimensions

Before designing work facilities that will facilitate the work of milling operators in coffee factories, it is necessary to process human body anthropometric data related to the facilities to be designed.

4.1 Data uniformity test

A data uniformity test is used to identify and control non-uniform data that do not meet specifications. If one or more data points in a dimension measurement fall outside the control limits, the data will be either immediately rejected or revised by removing the outliers and recalculating. The results of the data uniformity test are summarized in Table 4.

Table 4. Recapitulation of Data Uniformity Test

No	Dimension	$\bar{X}$	σ	UCL	LCL	Remarks
1	Standing Elbow Height (SHE)	108	6,1	120,2	95,8	Unifrom
2	Forward Arm Reach (FAR)	81,2	4,4	90,1	72,3	Unifrom
3	Shoulder Width (SH)	48	6,8	61,6	34,4	Unifrom
4	Hand Grip Height (HGH)	103,2	6,2	115,6	90,8	Unifrom

4.2 Data adequacy test

The data adequacy test calculation utilizes anthropometric data with a 95% confidence level and a 5% accuracy level. If the calculated N' value is less than N, the data is deemed sufficient; otherwise, if N' is greater than N, the data is considered insufficient.
The results of the data adequacy test calculation are presented in Table 5.

Table 5. Recapitulation of Data Adequacy Test

No	Dimensio	N	$\sum X$	$\sum Xi^2$	N'	Remarks
1	SHE	6	648	70,17	4,2	Sufficien
2	FAR	6	487	39,62	4,1	Sufficien
3	SH	6	288	13,85	3,9	Sufficien
4	HGH	6	619	64,05	4,8	Sufficien

4.3 Percentile calculation

Based on the anthropometric measurement results, the design of ergonomic work facilities will be discussed. The calculated percentile values are presented in Table 6.

Table 6. Percentile Calculation

No	Measurement	Symbol	Percentile (cm)		
			5-Th	50-Th	95-Th
1	Standing Elbow Height	SHE	97,98	108	118,01
2	Forward Arm Reach	FAR	73,87	81,2	88,52
3	Shoulder Width	SH	36,81	48	59,18
4	Hand Grip Height	HGH	93	103,2	113,3

After determining the percentile size, the next step is to establish the dimensions of the work facilities, which are presented in Table 7.

Table 7. Use of Percentiles

No	Anthropometric Data	Measurement (cm)	Function/Description
1	Standing Elbow Height	108	The height of the work surface box is determined to be 108 cm, designed to accommodate the worker's elbow position when standing.
2	Forward Arm Reach	81,2	The box length is determined to be 81.2 cm, allowing all workers to easily reach inside without overextending.
3	Shoulder Width	48	The box width is determined to be 48 cm, designed to match the workers' shoulder breadth and ensure an ergonomic posture.
4	Hand Grip Height	103,2	The box handle height is determined to be 103.2 cm, allowing for a comfortable grip without straining the arms or shoulders.

5 Research methodology

5.1 Research location and timeline

This research was conducted on Indaco and Arasco workers in Jeumpa Sub-district, Bireuen Regency, specifically at the coffee bean grinding station.

5.2 Research Subject

This study observed the work postures of Indaco and Arasco workers in Jeumpa District, Bireuen Regency, specifically during the coffee bean grinding process. The process consists of two main activities: retrieving coffee beans and lifting them to the grinding machine. This research focuses on each activity separately, with Indaco workers observed during the coffee bean retrieval activity and Arasco workers observed during the lifting activity.

6 Discussion of results

6.1 Work posture analysis using OWAS and REBA methods

Based on the analysis using the OWAS method, it was found that three operators who performed the activity of retrieving coffee beans scored in category 3 (corrective action needs to be taken soon), while three operators who lifted coffee beans to the grinding machine scored in category 4 (immediate action is highly necessary). This indicates the presence of bending postures, heavy loads of 25 kg, and unbalanced body weight distribution. Using the REBA method, the first three operators scored 10 (high risk), and the other three operators scored 11 (very high risk). This confirms the urgency of improving postures to prevent musculoskeletal disorders.

6.2 Product design

The design of an ergonomic coffee bean storage box was based on the anthropometric data of workers presented in Table 1. In the design process, four main dimensions were considered to ensure compatibility with the workers' bodies, namely: Standing Elbow Height (SHE), Forward Arm Reach (FAR), Shoulder Width (SH), and Hand Grip Height (HGH).

After conducting uniformity and sufficiency tests, the results showed that the data were uniform and sufficient, as seen in Tables 4 and 5. Next, percentile calculations (5th, 50th, 95th) were

performed to ensure that the design met the needs of the general worker population, as presented in Tables 6 and 7.
Based on these calculations, the design of the coffee bean storage box was made with the following dimensions: Height: 108 cm (based on SHE 50th percentile), Length: 81.2 cm (based on FAR 50th percentile), Width: 48 cm (based on SH 50th percentile), Handle height: 103.2 cm (based on HGH 50th percentile)

The coffee bean storage box is also equipped with wheels for easy mobility and is placed near the grinding machine to reduce transportation distance, thereby increasing efficiency and workplace safety. With this ergonomic design, it is expected that worker comfort and safety can be improved. The design of the coffee bean storage box can be seen in Figure 7, which shows the final design of the box that has been designed based on the anthropometric data of workers.

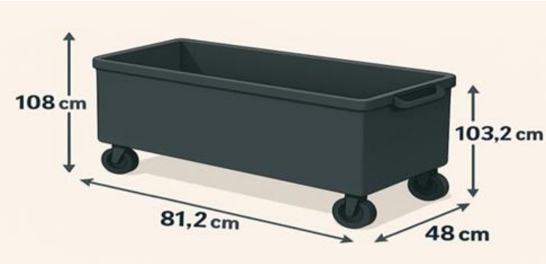

Fig. 7. Illustration of Proposed Facilities in the Form of Coffee Storage Boxes

6.3 Analysis of work posture after using ergonomic products using OWAS and REBA methods

The analysis of work posture after implementing ergonomic products for six coffee factory operators using the OWAS and REBA methods shows that the use of coffee storage boxes designed according to the operators' working postures and equipped with wheels for easy mobility can reduce the work posture score from a high-risk category to a moderate-risk category. Placing the storage boxes near the grinding machine also reduces the physical workload of workers by minimizing the distance between storage and processing areas. The results of this analysis indicate that ergonomic improvements can reduce the risk of musculoskeletal disorders (MSDs) among workers. The results of this analysis can be seen visually in Figures 8-13.

1. Operator 1
   Figure 8 shows the activity carried out by Operator 1, namely, retrieving coffee beans for grinding. Figure 8 shows the activities carried out by Operator 1, namely, taking coffee beans to be ground. The back posture is bent 30^0, the arm posture of both hands is under the shoulder, the leg posture is facing one another, both legs are straight, and lifting a load weighing 10 kg.

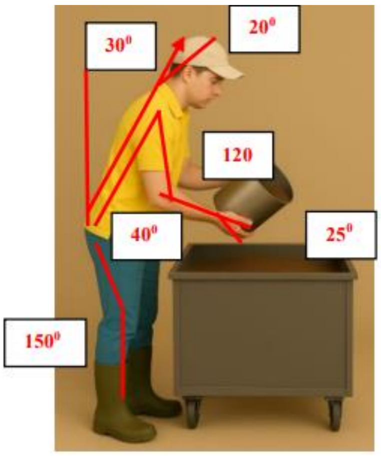

Fig. 8. Activity of taking coffee beans to be ground by operator 1.

2. Operator 2
   Figure 9 shows the activity carried out by Operator 2, involving the retrieval of coffee beans for grinding. The back posture is bent 25^0, both arms positioned below shoulder height, legs straight and facing each other, and lifting a load weighing 10 kg.

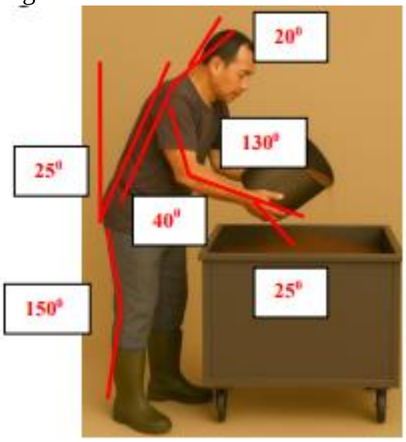

Fig. 9. Activity of taking coffee beans to be ground by operator 2.

3. Operator 3
   Figure 10 shows the activity carried out by Operator 3, namely retrieving coffee beans for grinding. namely taking coffee beans to be ground. The back posture is bent 35^0, the arm posture of both hands is under the shoulder, the leg posture is facing one another, both legs are straight and lifting a load weighing 10 kg.

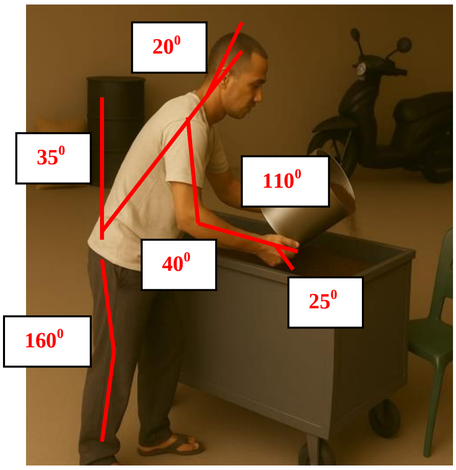

Fig. 10. Activity of taking coffee beans to be ground by operator 3.

4. Operator 4
   Figure 11 shows the activity performed by Operator 4, namely lifting coffee beans to the grinding machine. The posture involves a 20^0 forward bend of the trunk, 20^0 neck flexion, legs straight and bearing weight evenly, 60^0 elevation of the upper arms, 100° flexion of the for lower arm, and 25^0 wrist angle while lifting a load of 10 kg.

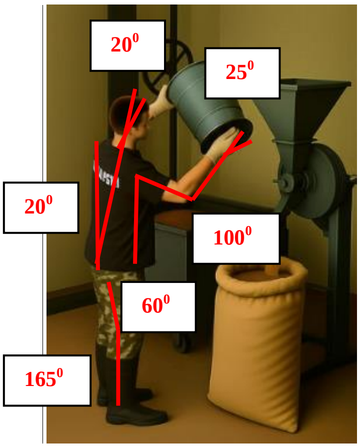

Fig. 11. Activity of lifting coffee beans to the grinding machine by operator 4

5. Operator 5
   Figure 12 shows the activity performed by Operator 5, namely lifting coffee beans to the grinding machine. The posture involves a 20^0 forward bend of the trunk, 20^0 neck flexion, legs straight and bearing weight evenly, 50^0 elevation of the upper arms, 60° flexion of the lower arm, and 20^0 wrist angle while lifting a load of 10 kg.

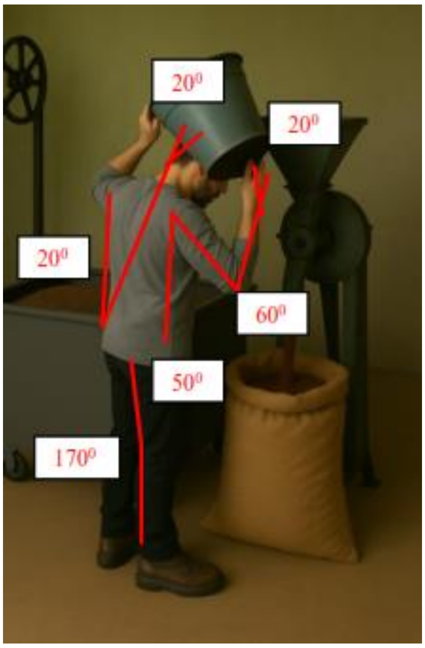

Fig. 12. Activity of lifting coffee beans to the grinding machine by Operator 5

6. Operator 6
   Figure 13 shows the activity performed by Operator 6, namely lifting coffee beans to the grinding machine. The posture involves a 20^0 forward bend of the trunk, 20^0 neck flexion, legs straight and bearing weight evenly, 55^0 elevation of the upper arms, 60° flexion of the lower arm, and 20^0 wrist angle while lifting a load of 10 kg.

Fig. 13. Activity of lifting coffee beans to the grinding machine by operator 6

The results of the comparison of work postures before and after improvement based on the OWAS and REBA methods can be seen in Tables 8 and 9.

Table 8. Comparison of Work Posture Before and After Improvement Using the OWAS Method

No	Before Repair		After Repair	
	Final Score	Action	Final Score	Action
1	3	Corrective action should be taken as soon as possible	2	Improvement may be needed in the future
2	3	Corrective action should be taken as soon as possible	2	Improvement may be needed in the future
3	3	Corrective action should be taken as soon as possible	2	Improvement may be needed in the future
4	4	Immediate action is required.	2	Improvement may be needed in the future
5	4	Immediate action is required	2	Improvement may be needed in the future
6	4	Immediate action is required	2	Improvement may be needed in the future

Based on the comparison of work postures before and after improvement using the OWAS method in Table 7, it is evident that there is a significant reduction in ergonomic risk scores for all operators. Specifically, the first, second, and third operators, who initially scored 3 (indicating the need for immediate corrective action), improved to a score of 2, signifying that their postures are now acceptable but still require attention. Moreover, the fourth, fifth, and sixth operators, who initially scored 4 (high-risk category requiring immediate action), successfully reduced their scores to 2 after improvement, indicating that their postures are now acceptable but still need monitoring.

Table 9. Comparison of Work Posture Before and After Improvement Using the REBA Method

No	Before Repair			After Repair		
	Grand Score	Action Level	Action	Grand Score	Action Level	Action
1	10	3	Corrective	5	2	Action is

			action is required			recommended
2	10	3	Corrective action is required	5	2	Action is recommended
3	10	3	Corrective action is required	5	2	Action is recommended
4	11	4	Immediate action is required	6	2	Action is recommended
5	11	4	Immediate action is required	6	2	Action is recommended
6	11	4	Immediate action is required	6	2	Action is recommended

The comparison of work postures before and after improvement using the REBA method revealed that the first, second, and third operators initially scored 10, corresponding to action level 3, which indicates that corrective action is necessary soon. Meanwhile, the fourth, fifth, and sixth operators scored 11, corresponding to action level 4, signifying that immediate action is required. After implementing the proposed ergonomic improvements, all operators' scores decreased to 5 and 6, corresponding to action level 2, indicating that while further adjustments are still needed, they are not urgently required.

6.4 Research Limitations

This study has several limitations that need to be considered:

1. Limitation in capturing initial posture photos due to factory environment conditions. Taking photos from the right side of the operator was obstructed by machinery, while taking photos from the left side resulted in blurry images due to sunlight entering from the open air space in the factory.
2. The small sample size (6 workers) limits the generalizability of the research findings.
3. Not all initial posture photos were taken from a plane parallel to the body, which may affect the validity of the posture analysis.
4. Post-intervention evaluation was not conducted longitudinally (long-term), which may not determine the effectiveness of the intervention over a longer period.

6.5 Recommendations for Future Research

Based on the limitations of this study, several recommendations for future research are:

1. Using a larger sample size from various factories to obtain more representative anthropometric data.
2. Using EMG or posture sensor measurements to obtain more objective results.
3. Conducting long-term evaluations of the reduction in injury risk and work productivity.

By doing so, future research can yield more accurate results that can be generalized more effectively.

7. Conclusion

This study concludes that coffee bean handling and grinding activities in coffee factories pose significant ergonomic risks that can lead to musculoskeletal disorders (MSDs). Based on the OWAS and REBA analyses, the coffee bean handling process at Indaco presented a risk level requiring immediate improvement, with OWAS scores of 3 and REBA scores of 10, indicating a high-risk category. Meanwhile, at coffee bean grinding section in Arasco, the ergonomic risk was even higher, as Operators 2, 3, and 4 obtained OWAS scores of 4 and REBA scores of 11, both classified as very high risk and requiring prompt corrective action. These findings highlight the urgent need for ergonomic interventions, particularly in workstations involving repetitive bending and heavy lifting. The use of ergonomically designed, height-adjustable, and movable coffee storage boxes is recommended to support better working posture and reduce MSD risks. Future research should expand the sample size across multiple factories, employ objective posture or muscle activity measurements (such as EMG sensors), and assess the long-term effects of ergonomic interventions on injury reduction and work productivity.

References

[1] Kee, D., “Comparison of OWAS, RULA and REBA for assessing potential work-related musculoskeletal disorders,” International Journal of Industrial Ergonomics, vol. 83, pp. 103140, 2021.

[2] M. A. Munanda, M. Iqbal, and M. Dirhamsyah, “Ergonomic working posture analysis on highway construction work using the OWAS method,” Jurnal Polimesin, vol. 22, no. 6, pp. 612–619, 2024.

[3] M. Iqbal, I. Hasanuddin, R. Aleyzia, R. Safitriyawi, and A. Hassan, "Analysis of Working Posture on Tofu Factory Operator Activities Using RULA Method and Virtual Engineering Software," in Proc. Int. Conf. Experimental and Computational Mechanics in Engineering, pp. 299–309, 2021.

[4] M. Iqbal, L. Angriani, I. Hasanuddin, F. Erwan, H. Soewardi, and A. Hassan, "Working posture analysis of wall building activities in construction works using the OWAS method," IOP Conf. Ser.: Mater. Sci. Eng., vol. 1082, no. 1, p. 012008, 2021.

[5] W. Spalanzani, “Identifikasi postur kerja dengan metode OWAS untuk memperbaiki postur kerja guna mengurangi musculoskeletal disorder,” Jurnal Jaring SainTek, vol. 5, no. 1, pp. 1–12, 2023.

[6] M. A. Munanda, M. Iqbal, and M. Dirhamsyah, “Ergonomic working posture analysis on highway construction work using the OWAS method,” Jurnal Polimesin, vol. 22, no. 6, pp. 612–619, 2024.

[7] Ö. A. Korkmaz and M. Ünver, “The ergonomic posture assessment by comparing REBA with RULA & OWAS: A case study in a gas springs factory,” Sigma Journal of Engineering and Natural Sciences, vol. 42, no. 5, pp. 1581–1603, 2024.

[8] Joshi, Mangesh, and Vishwas Deshpande. "Investigative study and sensitivity analysis of Rapid Entire Body Assessment (REBA)." *International Journal of Industrial Ergonomics* 79 (2020): 103004.

[9] F. Ghasemi and N. Mahdavi, “A new scoring system for the Rapid Entire Body Assessment (REBA) based on fuzzy sets and Bayesian networks,” International Journal of Industrial Ergonomics, vol. 80, p. 103058, 2020.

[10] C.L.S.Asda, I. Hasanuddin, Husni, and T. Firsa, "Analysis of worker posture of Make-Up Artist by Standard Nordic Questionnaire method and Rapid Entire Body Assessment," Jurnal Polimesin, vol. 22, no. 6, pp. 681–685, 2024.

[11] I. Hasanudin, N. Nazaruddin, and F. Farida, "Analisa Pengukuran Antropometri Telapak Tangan (Studi Kasus Pada Pengguna Kawat Gigi di Kota Banda Aceh)," J. Ind. Sci. Technol., vol. 4, no. 2, 2022.

[12] J. F. Andia-Fernandez, K. B. Ojeda-Soto, and E. Altamirano-Flores, “Anthropometric methods for the reduction of accidents due to musculoskeletal disorders in a company of the industrial sector,” in Proc. 8th Int. Conf. Industrial and Business Engineering (ICIBE), 2022.

[13] I. Z. Sutalaksana and A. Widyanti, “Anthropometry approach in workplace redesign in Indonesian Sundanese roof tile industries,” International Journal of Industrial Ergonomics, vol. 53, pp. 299–305, 2016.