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MUSCULOSKELETAL DISORDERS RISK LEVELS IN TOFU WORKERS IN NORTH ACEH: AN ERGONOMIC ASSESSMENT

Cut Ita Erliana[1], Iskandar Hasanuddin[2*] , Yuwaldi Away[3], Raja Ariffin Raja Ghazilla[4]
Doctoral Program, School of Engineering, Universitas Syiah Kuala, Banda Aceh, 23111 Indonesia[1]
Department of Industrial Engineering, Universitas Malikussaleh, Lhokseumawe, 24311, Indonesia[1]
Department of Mechanical and Industrial Engineering, Universitas Syiah Kuala, Banda Aceh, 23111, Indonesia[2]
Department of Electrical and Computer Engineering, Universitas Syiah Kuala, Banda Aceh, 23111, Indonesia[3]
Department of Mechanical Engineering, Faculty of Engineering, Universiti Malaya, Kuala Lumpur,50603, Malaysia[4]
iskandarhasanuddin@unsyiah.ac.id

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**Corresponding Author*

ABSTRACT
Tofu is a soy-based food that is popular in Indonesia. One of the supporting factors is that it has high nutritional value and low price. Tofu is produced by micro, small, and medium enterprises (MSMEs) in all provinces in Indonesia, including in the region of Aceh. Based on the results of observations, the tofu production process still predominantly uses human labor, starting from the washing process to the cutting process. This activity is carried out every day with a high repetition rate. If this is allowed to happen for a long time, workers will be exposed to the risk of musculoskeletal disorders. This study uses the Cornell Musculoskeletal Disorders (CMDQ) questionnaire to assess the workers' work posture and determine the level of occupational hazard risk using the Rapid Entire Body Assessment (REBA) method. The results of the distribution of questionnaires show that the body parts that experienced pain complaints were the shoulder (right dan left), upper back, upper arm (right and left), lower back, forearm (right and left), also wrist (right and left). It happens in the filtering process. The results of the assessment of work posture with the REBA method show the score of work posture in the filtering process is 13, which means that the filtering posture of workers has a very high risk and must be improved immediately. The present research recommended additional intervention that includes engineering and administrative control methods for reducing those workers' complaints of muscle pain.
Keywords: *Cornell Musculoskeletal Discomfort Questionnaire, Musculoskeletal Disorders, Micro Small and Medium Enterprises, REBA*

1. Introduction

MSMEs, sometimes called micro, small, and medium-sized enterprises, are the major employers and the primary source of income for developing nations worldwide (Hermawati et al., 2014; Meilani et al., 2018; Baz et al., 2021). MSMEs are also more resilient to pandemics and economic crises (Kadeni, 2020). According to the Ministry of Cooperatives and Small and Medium Enterprises, Indonesia's micro, small, and medium enterprises reached 64.2 million in 2022, accounting for 61.07% of the GDP, or 8573.89 trillion. MSMEs can absorb 97% of the labor force and receive up to 60.42% of total investment in Indonesia. The importance of MSMEs is gradually being recognized. However, on the one hand, they still pay less attention to health and safety at work, so their incidence of occupational accidents and occupational diseases tends to be higher (Sain & Meena, 2016; Hosseinniakani et al., 2014). Lack of knowledge and awareness about occupational health and safety is one of the weaknesses of MSME occupational safety and health programs in developing countries (Prabarukmi & Widajati, 2021), as increased attention to improving MSME working conditions and occupational safety issues will have negative impacts on job productivity. Tremendous influence and the worker's life quality (Ramdan & Azahra, 2020). One of the biggest issues with occupational health is musculoskeletal disorders (Jain et al., 2020; Gómez-Galán et al., 2020; Chander & Cavatorta, 2017; Chiasson et al. 2012). Musculoskeletal disorders (MSDs) affect the normal function of the musculoskeletal system due to repeated exposure to various risk factors in the workplace. The musculoskeletal system includes tendons, tendon sheaths, ligaments, bursae, blood vessels, joints, bones, muscles, and nerves (Njaka et al., 2021). MSDs occur not directly but rather as a combination and accumulation of injuries continuously over a long period. MSDS causes significant work problems because it can increase compensation for health costs, decreased productivity, and low quality of life (Kee & Karwowski, 2007). MSDs account for 42%–58% of all occupational diseases and 40% of work-related health costs (International Labour Organization (ILO), 2018). The cost of losses due to MSDs is estimated to reach an average of 14,726 dollars per year or around 150 million rupiahs, so if this MSD problem is not immediately prevented, it can cause work processes to be hampered and not optimal. Workers at high risk of experiencing MSDs do monotonous work and have a high frequency of repetition (Lim et al., 2022; Humphreys & Verstappen, 2022) .

Tofu MSMEs are one of the MSMEs in the food processing sector which has proven to survive amid the economic crisis and pandemic (Tulhusnah, 2018). Existence of these MSMEs in almost all regions of Indonesia, Indonesians widely consume Tofu because it has high nutritional value and economical prices. Additionally, MSMEs tofu can be found in Aceh Province, particularly in North Aceh. Based on observations, they still carry out the conventional tofu production process, predominantly using human labor.

Generally, Tofu MSMEs have seven workstations: washing workstations, soaking workstations, milling workstations, boiling workstations, filtering workstations, printing and pressing workstations, also cutting workstations (Suhardi et al., 2020). Tofu is produced in a largely traditional manner (Rahmawati, 2013). After 20 minutes in a container, the washing soaks for six hours. Soybeans are ground using a machine in the milling procedure; this step takes 20 minutes. The boiling procedure comes next. In this instance, the worker's task is to move liquid soybeans (soybean porridge), which has been pulverized, to a cooking stove where it will be boiled for 15 minutes. The cooked soybean slurry is extracted for the filtering process, transferred into the furnace using a bucket with an average capacity of 5 liters, and then filtered. One filtering procedure takes 30 minutes to complete. The filtered liquid soybeans are printed into a mold covered in cloth before being supported and pressed for 30 minutes. Tofu that has hardened is chopped based on consumer preferences or requests. Ten minutes are spent trimming. Workers typically display a work attitude independent of ergonomics guidelines while at work. Work systems and manual work aids, as well as work postures that do not adhere to ergonomics norms and are performed with a high level of repetition, might result in MSD problems. The purpose of this study aimed to assess the ergonomic risk, mainly as it related to the Tofu worker's work posture (Iqbal et al., 2021).

2. Literature Review

Ergonomics

The science of ergonomics involves using information about human nature, abilities, and limitations to create functional systems that enable people to live and work appropriately, attaining desired goals through work successfully, healthily, comfortably, and efficiently (Karwowski & Szopa, 2021). Ergonomics is the study of human interactions and aspects of other work systems, such as materials and the environment, as well as methods and organization. It is not simply concerned with equipment (Bridger, 2008). The usefulness of conducting an ergonomics assessment in the workplace is reducing work accidents, reducing health problems for workers, increase productivity and work performance. Ergonomics is also used for organizational job design, improving occupational safety and health factors, product design, and evaluation (Zhang et al., 2023; Zerguine et al., 2023). Ergonomics seeks to balance the needs of workers as well as company owners. It can be accomplished by concentrating on several key goals, such as increasing worker productivity and emphasizing occupational health and safety (Kazemi & Lee, 2023; Amri & Putra, 2022).

Musculoskeletal Disorders (MSDs)

A majority of industries and countries encounter musculoskeletal disorders as health issues. (Humphreys & Verstappen, 2022) that occur due to work-related stresses such as repetitive movements, unnatural or non-ergonomic postures, long working hours, and high workloads (Karimi et al., 2020). Nerves, tendons, cartilage, ligaments, joints, and muscles are all affected by MSDs. MSDs are characterized by ongoing discomfort, aches, or pain, frequently leading to restricted mobility that reduces the affected person's function and productivity (Giovannico et al., 2020). Musculoskeletal complaints can be classified into temporary and persistent. Temporary complaints are musculoskeletal complaints that occur when the muscles receive a static load, meaning that the pain disappears immediately when the load is stopped. The complaints persist that arise because the skeletal muscles receive static loads. Meanwhile, persistent complaints are musculoskeletal complaints, meaning that pain in the skeletal muscles is still felt even though the load has disappeared. To solve the problem of MSDs, authors who specialize in human factors and ergonomics are frequently drawn to postural loading, the impact of vibration, the use of tools, coupling, unnatural postures, movement frequency and duration, work envelopes, and ergonomic workstation design (Joshi & Deshpande, 2020).

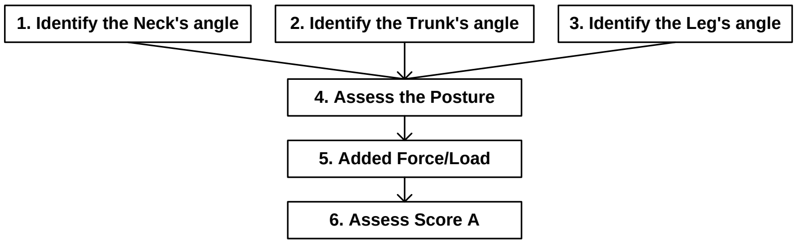
Cornell Musculoskeletal Discomfort Questionnaire (CMDQ)

The Cornell Musculoskeletal Discomfort Questionnaire (CMDQ) is subjective in the form of questions about limb disorders experienced at work related to work productivity. This questionnaire was developed by Professor Alan Hedge from Cornell University (Yusof & Shalahim, 2021). CMDQ is a combination questionnaire from the Nordic Body Map (NBM) with additional questions related to the severity level and the effect on the respondent's performance at work. Work Posture Work posture is the attitude of the body when working. Different work attitudes will produce different strengths. At work, posture should be done naturally to minimize musculoskeletal injuries. Comfort occurs when the worker has a good and safe working posture. Good working posture is primarily determined by the movement of body parts while working. There are various types of work posture assessment methods, including the Rapid Upper Limb Assessment method or RULA (Gómez-Galán et al., 2020; Chand & Bhasi, 2023; Kee, 2022), which is a work posture assessment method precisely for the upper part of the worker's body, Rapid Entire Body Assessment or REBA (Varghese et al., 2022; Hita-Gutiérrez et al., 2020), which is an overall work posture assessment method, Ovaco The Working Posture Analysis System or OWAS (Gómez-Galán et al., 2017), and the Quick Exposure Checklist or QEC (Sultana et al., 2019) works posture methods that quickly assess the risk of work-related skeletal muscle disorders.

Rapid Entire Body Assessment

REBA is widely used and employed in numerous industries (Hita-Gutiérrez et al., 2020). The REBA approach expedites the postural analysis. The movement of every part of the body while working is taken into assessment, making it the most comprehensive assessment technique. To assess probable musculoskeletal diseases at work, REBA was created. REBA aims to segment the body into distinct parts that can each be separately coded in light of movement angles (Nabil & Dahda, 2022). According to a body part diagram, the observer in this method assigns ratings based on body posture alignment. Calculation includes weight on muscles and coupling scores. Values from both categories must be added together for the final analysis. This straightforward evaluation sheet has always helped assess postural and biomechanical loads successfully. The scores determine how each bodily part is positioned. Section A of the postural assessment uses the neck, trunk, and legs, while Section B uses a conventional table to score the upper arm, lower arm, wrist, and wrist twist. According to the scoring system, weight on body parts adds additional numbers to the risk-involved score. When scoring A and score B are added together, a total is recorded, which aids in evaluating C on the evaluation form. REBA also highlights a level of urgency for acting. The method was created to assess MSDs working postures that pose issues in the healthcare or service industries. Figure 1 below shows the steps in the REBA method.

Part A: Analysis of the Neck, Trunk, and Leg



Part B: Analysis of the Arm and Wrist

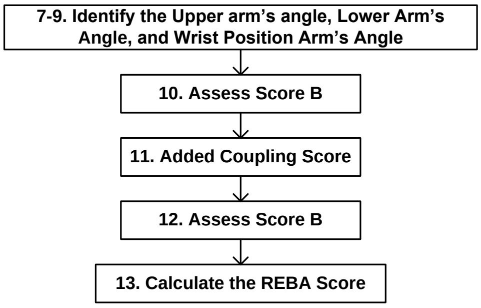


Fig. 1. The REBA method step

The associated risk level category can be determined using the REBA score that has been calculated (Table 1). Different action categories have different meanings depending on the urgency of necessary corrective action. The lower the REBA score, the lesser the urgency (Joshi & Deshpande, 2020).

Table 1 - REBA scores and associated conclusion

Action Level	REBA Score	Action
1	1	Negligible Risk
2	2-3	Low Risk. Change may be needed
3	4-7	Medium Risk. Further Investigate. Change Soon
4	8-10	High Risk. Investigate and Implement Change
5	11+	Very High Risk. Implement Change

Ergo fellow

Ergo fellow is software that has 17 supporting features to analyze, evaluate and improve workplace conditions, to reduce workplace risks and increase productivity from different perspectives (Drašković et al., 2020; Mistarihi, 2020) namely: Revised Lifting Equation (NIOSH), Ovako Working Posture Analyzing System (OWAS), Rapid Upper Limb Assessment (RULA), Rapid Entire Body Assessment (REBA), Suzanne Rodgers, Moore And Garg (The Strain Index), Discomfort Questionnaire, Quick Exposure Check (QEC), Lehmann, Image Analysis, Video Analysis, Anthropometry, Calculation of force, Personal Protective Equipment (PPE), Heat Stress, Noise Exposure (OSHA), and Typing Evaluation. Motion Time Study Job research and work method analysis will focus on how (how) a type of work will be completed. Applying the principles and techniques of setting optimal working methods in the work system. Figure 2 below shows the results of the ergo-fellow assessment of the Reba score.

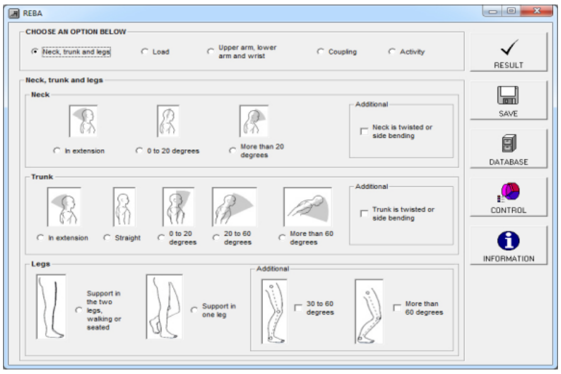


Fig. 2. The Ergo-fellow Assessment of the REBA Score

3. Research Methods

Study Design

This research with a cross-sectional approach was conducted on Tofu Micro, Small, and Medium Enterprises (MSMEs) in North Aceh, Indonesia. Seventy-seven male employees are working for 21 MSMEs in this area. Two phases of data collection were used. Phase I collected data on self-reported musculoskeletal symptoms, demographics, work-related characteristics, and the CMDQ; Phase II assessed the working posture using REBA.

Questionnaire

The demographic, work-related, and CMDQ questions were collected in one questionnaire. Age, marital status, educational background, and smoking habit were assessed as demographic characteristics. In addition to questions about tool design and workers' satisfaction with tool design, the work-related survey also asked about employment experience, job satisfaction, job rotation, and workplace pressure. Job rotation is a strategy for transferring workers between tasks with various occupational demands and exposure levels to reduce the risk of MSDs. The following sample questions are: "How satisfied are you with the work? Low, medium, and high. Do you believe you need to put forth a lot of effort? "Are you interested in job rotation?" "Are you interested in job rotation? (yes/no)", "Do you have any work experience in the Tofu industry? " and "What is your level of satisfaction with the tool's design? (low, moderate, high)". We compiled the workers' MSD symptoms in terms of Frequency, severity, and Interference with work using a CMDQ sheet.

The CMDQ questionnaire and the REBA method were also disseminated to get the results. The CMDQ form asks about work interference, severity, and Frequency. According to the CMDQ rating rules (Table 1), assign each team a weighting. Use the following equation to determine the points allotted to each section:

F = S = I = $\sum_{i=1}^{w} n_i \; x \; W_{\,i}$

Total discomfort score = F*S*I
F = Frequency score
S = Severity score
I = Interference score

Where n_i is the total number of people with a particular MSD symptom, and W_i is the weight of the associated symptom. Frequency, severity, and interference scores are multiplied together to arrive at a total discomfort score for a worker's specific body region (Rathore et al., 2020)

Table 2 - The Weighting of Frequency, Severity, and Interface on a Different Scale

Frequency	Severity	Interference
0.0 = never	1 = Slightly	1 = Not interfered
1.5 = 1-2 times per week	2 = Mod uncomfortable	2 = Slightly interfered
3.5 = 3-4 times per week	3 = Very uncomfortable	3=Substantially interfered
5.0 = once a day		
10 = several times every day		

Posture Analysis

Through a direct observational method, the REBA technique was used to analyze the subject's posture. A reliable and effective observational process for assessing working posture at the workplace is REBA.

To obtain the total REBA grand score, which indicates the risk level of the posture, the working posture of the various body areas of the tofu-making workers was directly observed, followed by photography and video. The authors assessed each worker's longest-used working posture throughout the job cycle. Each worker's three REBA scores. Score A (neck, leg, and trunk), score B (upper arm, lower arm, and wrist), and the overall REBA score were recorded on a separate REBA evaluation form. Table 1 shows the risk and recommended action levels following the REBA overall score.

4. Results and Discussions

Demographic and Work-Characteristics

This research was conducted on tofu SMEs in North Aceh Regency and Lhokseumawe City, Aceh. There were 77 workers involved in the study. Tables 3 and 4 below show the demographic data of workers.

Table 3 - Demographic Details of The Workers (N = 77)

Study Variables		
Age (Year)	Average	29,86
	Range	18-50
	Deviation	7,99
Marital Status	Married	27 (35,1%)
	Single	50 (63,9%)
Education	Bachelor	3 (3,9%)
	High School	74 (96,1%)
Smoking (%)	Yes	59 (76,6%)
	No	18 (23,4%)

Table 4 - Work-Characteristics of The Workers (N = 77)

Study Variables		
Job experience (year)	1 - 5	42 (54,6%)
	6- 10	28 (36,4 %)
	11 – 20	7 (9,1 %)
Working very fast	Yes	77 (100%)
	No	0 (0%)
Job Stress	Yes	56 (72,7%)
	No	21 (27,3%)
Job Satisfaction	Low	58 (75,3%)
	High	19 (24,7%)
Satisfy with tofu tools design.	Low	57 (74%)
	High	20 (26%)

Tables 3 and 4 provide information on worker demographics and statistics on characteristics connected to their jobs. The workers range in age from 18 to 50. 35.1% of the workers were married, on average. Most workers smoked where they worked. The job descriptions of more than half of the workers were unsatisfactory, and all the workers ' jobs required speedy labor. 56% of interviewees report working after midnight and being under pressure to deliver products. More than 50% of the workers disliked the tofu tool's design.

Posture Analysis

We calculated the REBA score using the ergo-fellow software, which identifies the posture's risk level and offers suggestions for corrective action. In advance of that, 77 tofu workers completed a CMDQ questionnaire to identify the areas of their bodies that discomforted them.

Table 5 - Prevalence of MSD Symptoms for The Corresponding Body Parts of Workers

Body Regions	Section I Frequency of discomfort in last week					Section II Severity of discomfort			Section III Discomfort interfered with work?		
	Never	1-2 times in a week	3-4 times in a week	once in a day	Several times in a day	Slightly	Moderate	Very	Not	Slightly	Substantially
Neck			46	25	6	46	31		46	31	
Shoulder (Right)				25	52	7	20	50		8	69
Shoulder (Left)				25	52	7	20	50		8	69
Upper back			3	30	44	3	33	41	3	33	41
Upper arm (right)			17	20	40	5	17	55	5	10	62
Upper arm (left)			17	20	40	5	17	55	5	10	62
Lower back			3	30	44	3	33	41	3	33	41
Forearm (right)			10	24	43	2	20	55		22	55
Forearm (left)			10	24	43	2	20	55		22	55
Wrist (right)				20	57	3	4	70	3	4	70
Wrist (left)				20	57	3	4	70	3	4	70
Panggul			55	19	3	55	22		55	22	
Thigh (right)			62	14	1	62	15		62	15	
Thigh (left)			62	14	1	62	15		62	15	
Knees (right)			49	26	2	49	28		49	28	
Kness (left)			49	26	2	49	28		49	28	
Foot (right)		24	35	12	6	24	48	5	24	48	5
Foot (left)		24	35	12	6	24	48	5	24	48	5
Average	0.00	2.67	25.17	21.44	27.72	22.83	23.50	30.67	21.83	21.61	33.56
%	0.00	3.46	32.68	27.85	36.00	29.65	30.52	39.83	28.35	28.07	43.58

The first section of Table 5 displays the Frequency of discomfort experienced by tofu workers in various body parts over the previous week. The second section displays the severity of the discomfort, and the final section displays the effects of the discomfort on work. Every participant complains at least once every day. Many individuals described the discomfort as moderate (30.52%) to very uncomfortable (39.83%), with varying degrees of disturbance with their job (28.07% to 43.58%). We determined the Frequency, severity, and discomfort values using weighted Table 2. Let's use equation (1) below to determine the whole neck region discomfort score:

Frequency score

(F) = 0*0 + 0*1.5 + 46*3.5 + 25*5 + 6*10 = 346

Severity score

(S) = 46*1 + 31*2 + 0*3 = 108

Interference score (I) = 46*1 + 31*2 + 0*3 = 108

Using equation (2), We estimated the total discomfort score in the neck region as follows:

Total discomfort score = F*S*I = 346*108*108 = 4035744

$$\frac{Total\ discomfort\ score\ for\ the\ neck}{total\ discomfort\ score} = \frac{4035744}{29459111.5} = 1.37\%$$

Table 6 - Total Discomfort Score and Percentage

Body Regions	Frequency Score (F)	Severity Score (F)	Interference Score (I)	Total Discomfort Score	% Total Discomfort Score
Neck	346	108	108	4035744	1.37
Shoulder (Right)	645	197	223	28335495	9.62
Shoulder (Left)	645	197	223	28335495	9.62
Upper back	600.5	192	192	22136832	7.51
Upper arm (Right)	559.5	204	211	24083118	8.18
Upper arm (Left)	559.5	204	211	24083118	8.18
Lower back	600.5	192	192	22136832	7.51
Forearm (Right)	585	207	209	25308855	8.59
Forearm (Left)	585	207	209	25308855	8.59
wrist	670	221	221	32723470	11.11
wrist	670	221	221	32723470	11.11
Hip	317.5	99	99	3111817.5	1.06
Thigh (Right)	297	92	92	2513808	0.85
Thigh (Left)	297	92	92	2513808	0.85
Knees (Right)	321.5	105	105	3544537.5	1.20
Knees (Left)	321.5	105	105	3544537.5	1.20
Foot (Right)	278.5	135	135	5075662.5	1.72
Foot (Left)	278.5	135	135	5075662.5	1.72
Total				294591117.5	100.00

We similarly generated total scores and percentages of discomfort for the workers' other body parts. The total ratings and discomfort ratios for the respective body locations are shown in Table 6. Nearly every part of the body of the participants was uncomfortable, but the left and right wrists (11.11%), left and right shoulders (9.62%), left and right forearms (8.59%), and left and right upper arms (8.18%) were particularly so. The most affected body part was the wrist (11.11%), while the least significant for ergonomic adjustments was the thigh (0.85%).

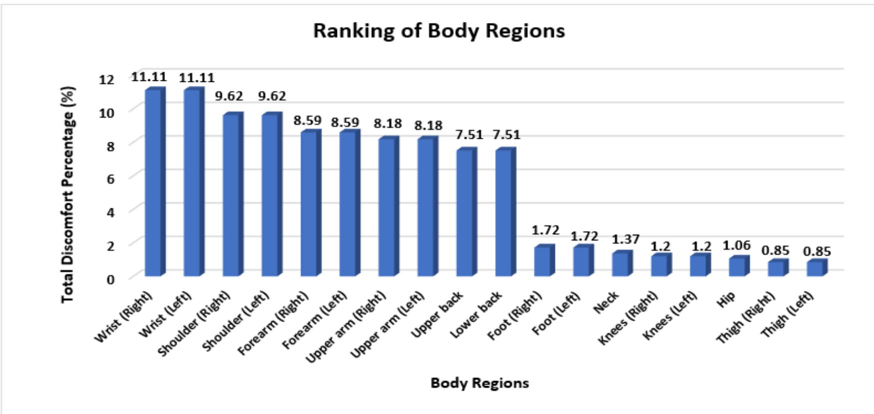


Fig. 3. Rank Body Parts Based on the Percentage of Discomfort Overall.

Figure 3 shows the ranking of the affected body regions according to their overall discomfort percentage, and it was observed that the rate of complete discomfort in the 18 body regions ranged from 0.85 to 11.611%. These results demonstrate that all 18 body regions of workers are relatively affected during their work and highlight the need for participatory interventions to reduce the severity of specific risk factors and MSDs effectively.

Every worker felt ill, which was the study's main finding (see Figure 4). Most workers reported the discomfort was moderate (30.52%) to very uncomfortable (39.83%) and that it had a slight to severe (43.58%) impact on their job (see Figures 5 and 6).

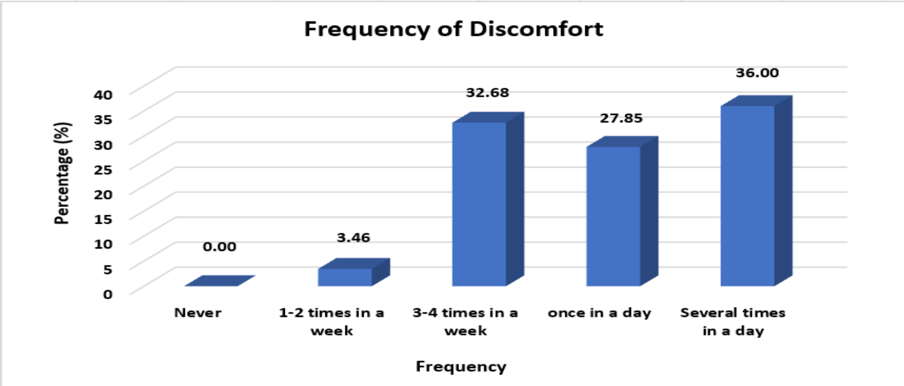


Fig. 4. Frequency of Discomfort

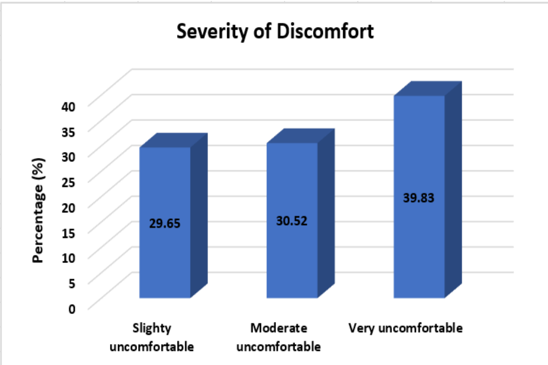


Fig. 5. Severity of Discomfort

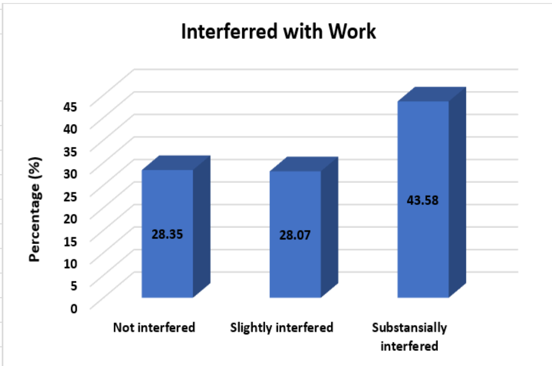


Fig. 6. Interferred with Work

According to the following graph, the wrist, shoulder, forearm, upper arm, upper back, and lower back suffer the most. Observations and interviews indicate that complaints of discomfort occur when filtering the ground tofu slurry. They are manually filtered, and the tofu pulp is placed in gauze and squeezed or pressed with both hands, as shown in Fig.8; if they use the filtering approach described above for an extended period, they risk developing musculoskeletal problems.

The next stage is applying the REBA approach to evaluate each workstation's work posture. The milling workstation is the first. The worker's work posture poses a low risk; according to a score of 3, however, changes may be needed. The software Ergo fellow is used for the evaluation procedure; see Fig. 7.

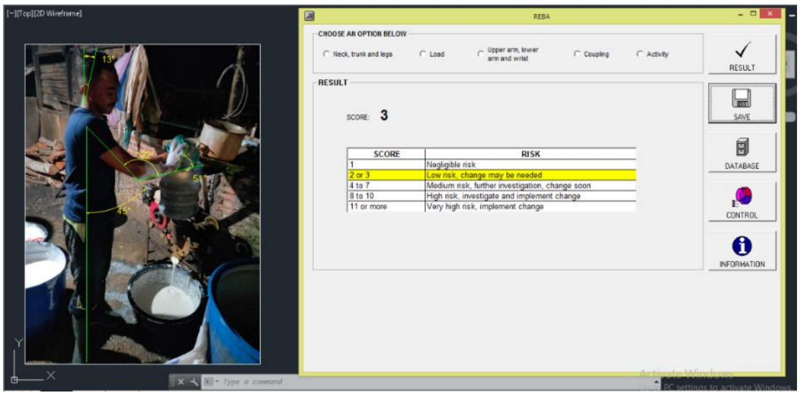


Fig.7. Posture Assessment Results in the Milling Workstation

The filtering workstation includes the following evaluation. A score of 13 indicates that changing the work posture is needed since it poses a significant risk to the worker. The evaluation procedure uses the Ergo fellow software (see Fig. 8).

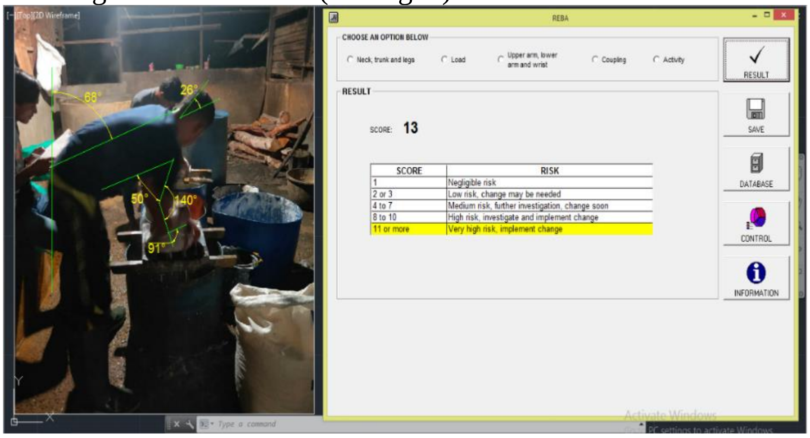


Fig. 8. Posture Assessment Results in the Filtering Workstation

The assessment following is in the boiling workstation. The worker's work posture poses a medium risk according to the score of 5. The software Ergo fellow is used for the evaluation procedure; see Fig. 9.

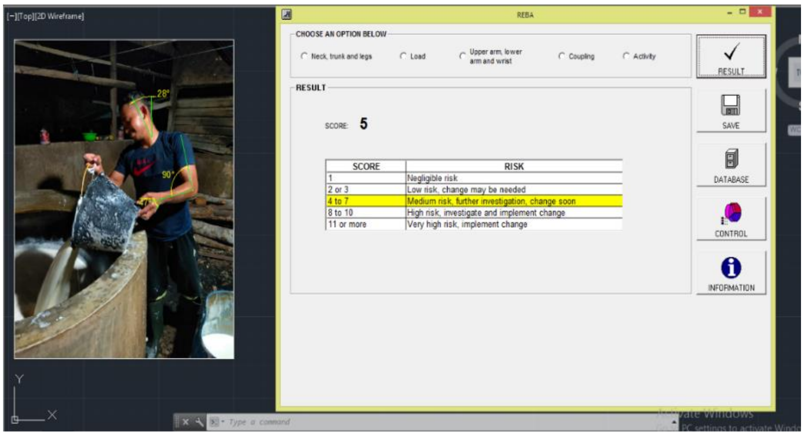


Fig. 9. Posture Assessment Results in the Boiling Workstation

The assessment was also conducted at the printing workstation, with a score of 3, indicating that a change may be needed due to the worker's low-risk work position. The software Ergo fellow, shown in Fig. 10, is used in the assessment process.

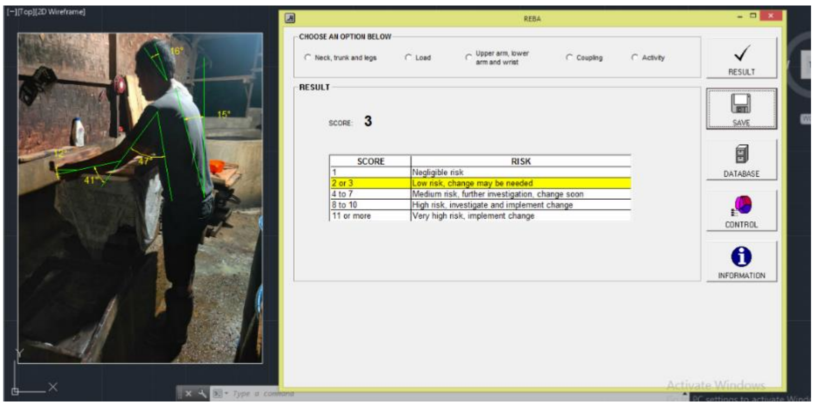


Fig. 10. Posture Assessment Results in the Printing Workstation.

The pressing workstation has the following assessment. A score of 10 indicates that modification is needed since the work posture is high risk. The evaluation procedure uses the Ergo fellow software (see Fig. 11).

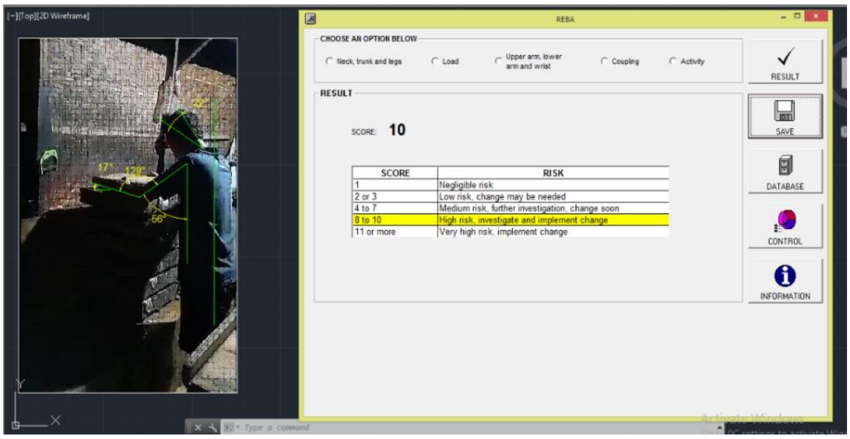


Fig. 11. Posture Assessment Results in the Pressing Workstation

The cutting workstation is where the final assessment is made. With a score of 2, the work position is low risk. However, modification may be needed. Ergo fellow software used in the evaluation process is shown in Figure 12.

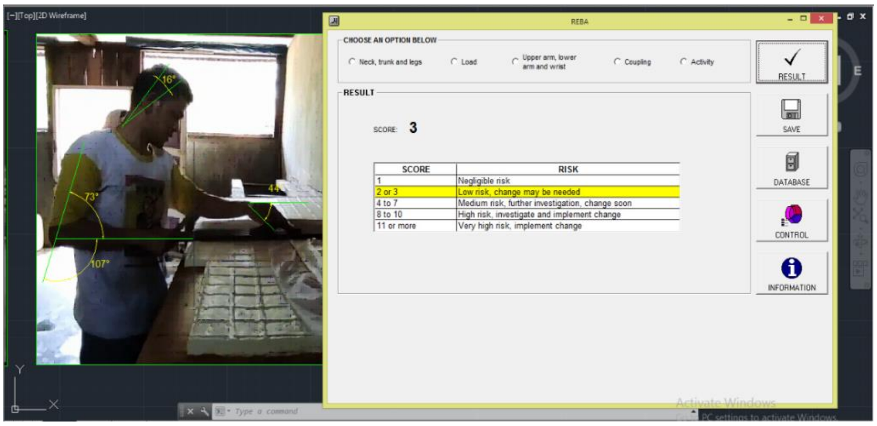


Fig.12. Posture Assessment Results in the Cutting Workstation

Table 7 provides a summary of the posture evaluation of all workstations.

Table 7 - Recapitulation of Worker Posture Assessment Results

No	WorkStation	Level of Risk	Risk Category	Action
1	Milling	3	Low	Change may be needed
2	Boiling	5	Medium	Further Investigate. Change Soon
3	Filtering	13	Very high	Implement Change
4	Printing	3	Low	Change may be needed
5	Pressing	10	High	Investigate and Implement Change
6	Cutting	2	Low	Change may be needed

5. Conclusion

All workers feel uncomfortable while working. The highest percentage of discomfort felt was in the wrists, shoulders, forearms, upper arms, and back when workers carried out the filtering process. This is in accordance with the results of the assessment of work posture with the REBA method, which show that the highest risk level is at the filtering workstation; the score is 13, meaning it must be improved immediately. Further research will be carried out to reduce the risk level of MSDs.

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References

Amri, A. N., & Putra, B. I. (2022). Ergonomic Risk Analysis of Musculoskeletal Disorders (MSDs) Using ROSA and REBA Methods On Administrative Employees Faculty Of Science. *Journal of Applied Engineering and Technological Science (JAETS), 4*(1), 104-110. https://doi.org/10.37385/jaets.v4i1.954

Baz, M., Alhakami, H., Agrawal, A., Baz, A., & Khan, R. A. (2021). Impact of COVID-19 Pandemic: A Cybersecurity Perspective. *Intelligent Automation & Soft Computing, 27*(3). http://dx.doi.org/10.32604/iasc.2021.015845

Bridger, R. (2008). *Introduction to ergonomics*. Crc Press.

Chand, A., & Bhasi, A. B. (2023). Anthropometric Assessment of Heavy-Duty Driver Postures Using RULA Method. *Transactions of the Indian National Academy of Engineering, 8*(4), 617-623. https://doi.org/10.1007/s41403-023-00420-z

Chander, D. S., & Cavatorta, M. P. (2017). An observational method for postural ergonomic risk assessment (PERA). *International Journal of Industrial Ergonomics, 57*, 32-41. https://doi.org/10.1016/j.ergon.2016.11.007

Chiasson, M. È., Imbeau, D., Aubry, K., & Delisle, A. (2012). Comparing the results of eight methods used to evaluate risk factors associated with musculoskeletal disorders. *International Journal of Industrial Ergonomics, 42*(5), 478-488. http://dx.doi.org/10.1016/j.ergon.2012.07.003

Drašković, D., Průša, P., Čičević, S., & Jovčić, S. (2020). The implementation of digital ergonomics modeling to design a human-friendly working process in a postal branch. *Applied Sciences, 10*(24), 9124. https://doi.org/10.3390/app10249124

Giovannico, G., Brindisino, F., Pappaccogli, M., Saltalamacchia, A., Bonetti, F., Tavarnelli, M., ... & Delitto, A. (2020). A description of Physical Therapists' Knowledge in Basic Competence Examination of Musculoskeletal Conditions: an Italian National Cross-Sectional Survey. *Muscles, Ligaments & Tendons Journal (MLTJ), 10*(4). http://dx.doi.org/10.32098/mltj.04.2020.03

Gómez-Galán, M., Callejón-Ferre, Á. J., Pérez-Alonso, J., Díaz-Pérez, M., & Carrillo-Castrillo, J. A. (2020). Musculoskeletal risks: RULA bibliometric review. *International journal of environmental research and public health, 17*(12), 4354. https://doi.org/10.3390/ijerph17124354

Gómez-Galán, M., Pérez-Alonso, J., Callejón-Ferre, Á. J., & López-Martínez, J. (2017). Musculoskeletal disorders: OWAS review. *Industrial health, 55*(4), 314-337. https://doi.org/10.2486/indhealth.2016-0191

Hermawati, S., Lawson, G., & Sutarto, A. P. (2014). Mapping ergonomics application to improve SMEs working condition in industrially developing countries: a critical review. *Ergonomics, 57*(12), 1771-1794. https://doi.org/10.1080/00140139.2014.953213

Hita-Gutiérrez, M., Gómez-Galán, M., Díaz-Pérez, M., & Callejón-Ferre, Á. J. (2020). An overview of REBA method applications in the world. *International journal of environmental research and public health, 17*(8), 2635. https://doi.org/10.3390/ijerph17082635

Hosseinniakani, S. M., Inacio, H., & Mota, R. (2014). A review on audit quality factors. *International Journal of Academic Research in Accounting, Finance and Management Sciences, 4*(2), 243-254. http://dx.doi.org/10.6007/IJARAFMS/v4-i2/861

Humphreys, J. H., & Verstappen, S. M. (2022). The burden of musculoskeletal disease. *Medicine, 50*(2), 82-84. https://doi.org/10.1016/j.mpmed.2021.11.002

Iqbal, M., Hasanuddin, I., Aleyzia, R., Safitriyawi, R., & Hassan, A. (2021, October). Analysis of Working Posture on Tofu Factory Operator Activities Using RULA Method and Virtual Engineering Software. In *International Conference on Experimental and Computational Mechanics in Engineering* (pp. 299-309). Singapore: Springer Nature Singapore.

International Labour Organization (ILO). (2018). *ILO: Unemployment and Decent Work Deficits to Remain High in 2018*. World Employment and Social Outlook – Trends 2018.

Jain, R., Rana, K. B., Meena, M. L., & Sidh, S. (2021). Ergonomic assessment and hand tool redesign for the small scale furniture industry. *Materials Today: Proceedings, 44,* 4952-4955. https://doi.org/10.1016/j.matpr.2020.12.762

Joshi, M., & Deshpande, V. (2020). Investigative study and sensitivity analysis of Rapid Entire Body Assessment (REBA). *International Journal of Industrial Ergonomics, 79,* 103004. https://doi.org/10.1016/j.ergon.2020.103004

Karwowski, W., Szopa, A., & Soares, M. M. (Eds.). (2021). *Handbook of standards and guidelines in human factors and ergonomics*. Crc Press.

Kadeni, N. S. (2020). Peran UMKM (Usaha Mikro Kecil Menengah) Dalam Meningkatkan Kesejahteraan Masyarakat. *Equilibrium: Jurnal Ilmiah Ekonomi dan Pembelajarannya, 8*(2), 191-200.. http://doi.org/10.25273/equilibrium.v8i2.7118

Karimi, A., Dianat, I., Barkhordari, A., Yusefzade, I., & Rohani-Rasaf, M. (2020). A multicomponent ergonomic intervention involving individual and organisational changes for improving musculoskeletal outcomes and exposure risks among dairy workers. *Applied Ergonomics, 88,* 103159. https://doi.org/10.1016/j.apergo.2020.103159

Kazemi, R., & Lee, S. C. (2023). Human Factors/Ergonomics (HFE) evaluation in the virtual reality environment: A systematic review. *International Journal of Human–Computer Interaction,* 1-17. https://doi.org/10.1080/10447318.2023.2227835

Kee, D. (2022). Systematic comparison of OWAS, RULA, and REBA based on a literature review. *International Journal of Environmental Research and Public Health, 19*(1), 595.

Kee, D., & Karwowski, W. (2007). A comparison of three observational techniques for assessing postural loads in industry. *International Journal of Occupational safety and ergonomics, 13*(1), 3-14. https://doi.org/10.1080/10803548.2007.11076704

Lim, M. C., Lukman, K. A., Giloi, N., Lim, J. F., Avoi, R., Rahim, S. S. S. A., & Jeffree, M. S. (2022). Prevalence of upper limb musculoskeletal disorders and its associated risk factors among janitorial workers: A cross-sectional study. *Annals of Medicine and Surgery, 73,* 103201. https://doi.org/10.1016%2Fj.amsu.2021.103201

Meilani, D., Zadry, H. R., Rahmayanti, D., & Saputra, D. A. (2018). Work System Improvement for a Sugarcane Block Enterprise Using 10 Physical Ergonomic Principles. *International Journal on Advanced Science, Engineering and Information Technology, 8*(4), 1077-1084. http://dx.doi.org/10.18517/ijaseit.8.4.3496

Mistarihi, M. Z. (2020). A data set on anthropometric measurements and degree of discomfort of physically disabled workers for ergonomic requirements in work space design. *Data in brief, 30,* 105420. https://doi.org/10.1016/j.dib.2020.105420

Nabil, L., & Dahda, S. S. (2022). Risk Analysis of the Packing Process at the Logistics Department of PT. XYZ used REBA method. *Journal of Applied Engineering and Technological Science (JAETS), 4*(1), 325-332. https://doi.org/10.37385/jaets.v4i1.1119

Njaka, S., Yusoff, D. M., Anua, S. M., Kueh, Y. C., & Edeogu, C. O. (2021). Musculoskeletal disorders (MSDs) and their associated factors among quarry workers in Nigeria: A cross-sectional study. *Heliyon, 7*(2). https://doi.org/10.1016/j.heliyon.2021.e06130

Prabarukmi, G. S., & Widajati, N. (2021). Relationship between Working Tenure and Working Posture with Musculoskeletal Grievance in Batik Madura Workers. *Indian Journal of Forensic Medicine & Toxicology, 15*(1), 79-86.. https://doi.org/10.37506/ijfmt.v15i1.13379

Rahmawati, F. (2013). *Teknologi proses pengolahan tahu dan pemanfaatan Limbahnya*. Yogyakarta: Universitas Negeri Yogyakarta.

Ramdan, I. M., & Azahra, A. (2020). Menurunkan Keluhan Gangguan Muskuloskeletal Pada Penenun Tradisional Sarung Samarinda Melalui Pelatihan Peregangan Otot di Tempat Kerja. *Jurnal Khatulistiwa Informatika, 3*(2), 109-117. https://doi.org/10.31294/jabdimas.v3i2.7508

Rathore, B., Pundir, A. K., & Iqbal, R. (2020). Ergonomic risk factors in glass artware industries and prevalence of musculoskeletal disorder. *International Journal of Industrial Ergonomics, 80,* 103043. https://doi.org/10.1016/j.ergon.2020.103043

Sain, M. K., & Meena, M. L. (2016). Occupational health and ergonomic intervention in Indian small scale industries: a review. *Int J Recent Adv Mechanical Engin, 5*(1), 13-24.. http://dx.doi.org/10.14810/ijmech.2016.5102

Suhardi, B., Sari, R. P., & Laksono, P. W. (2020). Perbaikan Proses Produksi pada IKM Tahu Sari Murni Mojosongo Menggunakan Metode Good Manufacturing Practice (GMP) dan Work Improvement In Small Enterprise (WISE). *Jurnal Intech Teknik Industri Universitas Serang Raya, 6*(1), 88-98. https://doi.org/10.30656/intech.v6i1.2297

Sultana, N., Mian, M. A. H., & Rubby, M. G. (2019). Risk and exposure of musculoskeletal disorders among dental surgeons working in Dhaka City. *Update Dental College Journal, 9*(1), 3-7. http://dx.doi.org/10.3329/updcj.v11i1.53002

Tulhusnah, L. (2018, October). Peningkatan Potensi Pangan Fungsional Ampas Tahu Menjadi Olahan Bergizi Pada Ukm Tahu dan Tempe. In *Conference on Innovation and Application of Science and Technology (CIASTECH)* (Vol. 1, No. 1, pp. 50-54). http://publishing-widyagama.ac.id/ejournal-v2/index.php/ciastech/article/viewFile/690/641

Varghese, A., Panicker, V. V., Abraham, J., Gimmi, J., Tom, J., & Desini, K. (2022). Ergonomic Risk Assessment of Rubber Tappers Using Rapid Entire Body Assessment (REBA). In *Recent Advances in Manufacturing Modelling and Optimization: Select Proceedings of RAM 2021* (pp. 709-717). Singapore: Springer Nature Singapore. https://doi.org/10.1007/978-981-16-9952-8_61

Yusof, A., & Shalahim, N. S. M. (2021). Prevalence of Musculoskeletal Discomfort Among Workers in a Medical Manufacturing Facility. *International Journal of Automotive and Mechanical Engineering, 18*(2), 8687-8694. https://doi.org/10.15282/ijame.18.2.2021.06.0662

Zerguine, H., Healy, G. N., Goode, A. D., Zischke, J., Abbott, A., Gunning, L., & Johnston, V. (2023). Online office ergonomics training programs: A scoping review examining design and user-related outcomes. *Safety Science, 158,* 106000. https://doi.org/10.1016/j.ssci.2022.10600

Zhang, M., Li, H., & Tian, S. (2023). Visual analysis of machine learning methods in the field of ergonomics—Based on Cite Space V. *International Journal of Industrial Ergonomics, 93*, 103395. https://doi.org/10.1016/j.ergon.2022.103395