



Analysis of Cleaning Service Work Postures to Reduce Musculoskeletal Injuries with the Posture Evaluation Index Approach

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Abstract

Ergonomics is one of the important concepts to be applied in the work environment in achieving occupational safety and health. Work postures during work that arise due to the active movement of several limbs with postures that are not ergonomic can pose a risk to workers. Musculoskeletal injuries generally occur due to excessive muscle contractions due to poor work attitudes and the provision of workloads that are too heavy with a long duration of loading. With the aim of this study is to determine the correct work posture using the Posture Evaluation Index so as to prevent and reduce Musculoskeletal injuries in Cleaning Service Employees at Hang Tuah 5 Sidoarjo High School. With the method used is PEI, which is a score parameter in the assessment of work postures included in the OWAS method and integrated with other studies such as RULA and REBA. In this study with a total of 10 employees in lifting gallons / goods, it can be seen that the unergonomic work posture resulted in a PEI value of 2.791 including the high category and improvements must be made immediately in the workplace area.

Introduction

Ergonomics is the science and technology of adapting activities and environments to people's abilities, dimensions, and needs to improve performance while enhancing comfort, health, and safety. According to Lintangari et al. (2020), PEI is a score parameter in work posture assessment included in the OWAS method and integrated with other studies such as RULA and REBA. This method aims to describe work positions that are or are not in accordance with the parameters of ergonomics. Work posture is the position of the body when working that arises from the active movement of several limbs such as the head, back and spine as a relative orientation of body parts to space (Rahman, 2017; Handayani, 2011; Suriya et al., 2019). The job of being a cleaning service where there are several body positions that workers often do, namely sweeping, cleaning floors and lifting weights. This is supported by research by Amran & Adibatina (2023) that when doing work, many workers do not understand well the initial position when doing standing work or lifting weights.

Musculoskeletal Disorders (MSDs) are complaints felt by someone on the skeletal muscle parts (Sani & Widajati, 2021; Mariawati et al., 2021). Musculoskeletal disorders consist of a wide range of complaints that differ in intensity and symptoms that can result in mild and moderate symptoms or chronic and disabling conditions. Musculoskeletal disorders that often occur are knee pain, upper back pain, lower back pain, ankle pain, shoulder pain and neck pain. In order to keep the environment clean, Hang Tuah 5 Sidoarjo High School has a

Cleaning Service employee, whose job is to sweep, clean floors, lift weights, clean bathrooms, cut grass and clean windows. With 10 hours of work, working with non-ergonomic postures for a long duration can pose risks to workers, such as lifting objects.

Ergonomics

Ergonomics is the science and technology that adapts activities and environments to the abilities, dimensions, and needs of people to improve performance while improving comfort, health, and safety (Salvendy, 2001). The main goal of applying ergonomics is to achieve the optimal quality of human life where humans are. Ergonomic risk factors are factors that have the potential to cause harm or negative effects on health in connection with ergonomics (Purbasari et al., 2019; Ross et al., 2016).

Musculoskeletal Disorder

Musculoskeletal injuries generally occur due to excessive muscle contractions due to poor work attitudes and the provision of workloads that are too heavy with a long duration of loading. Musculoskeletal system complaints are complaints on the parts of the skeletal muscles (skeletal) felt by a person ranging from very mild to very painful complaints (Sjøgaard et al., 2000). Complaints in the form of damage to joints, ligaments and tendons will occur if the muscles receive static loads repeatedly and for a long time, usually termed MSDs complaints or injuries to the musculoskeletal system (Purbasari et al., 2019; Odebiyi & Okafor, 2023).

Work posture

Work posture is the position of the body when working that arises from the active movement of several limbs such as the head, back and spine as a relative orientation of body parts to space (Pheasant & Haslegrave, 2006). Posture is a determining point in analyzing the effectiveness of a job. If the posture while working is good and ergonomic, the results obtained will be good too, but if the work posture while working is wrong or not ergonomic, the worker will easily fatigue and there can be abnormalities in the shape of the bones. If that happens, the results of the work done will decrease and not as expected (Mardiyanti, 2021).

PEI (Posture Evaluation Index)

PEI is a score parameter in work posture assessment included in the OWAS method and integrated with other studies such as RULA and REBA (Lintangsari et al, 2020; Gómez-Galán et al., 2020). The purpose of PEI is to optimize work postures ergonomically in the work environment so as to produce an index number that represents the level of comfort and health at work (Putri et al., 2022). Based on Oktaviani's research (2022), the calculation of the posture with the lowest PEI value is the most ergonomic worker posture standard. Based on Oktaviani's research (2022), the Posture Evaluation Index (PEI) score has a minimum value of 0.47 and a maximum of 3.42.

OWAS (Ovako Working Posture Analysis)

According to Oktaviani (2022), the Ovako work posture analysis system or commonly referred to as OWAS is one of the methods commonly used to measure the level of muscle fatigue in humans. According to Yanto & Sutrisno (2023), the OWAS method is one method that produces output that shows the category of work attitudes that can cause danger or risk of work accidents in the musculoskeletal section. One of the real proofs of the role of humans in the industrial world is when carrying, moving, and others (Andriyani et al., 2023). The results of the OWAS work posture analysis consist of four levels of work attitude scales that are dangerous for workers. The results of the OWAS work posture analysis consist of four levels of work attitude scales that are harmful to workers.

RULA (Rapid Upper Limb Assessment)

The RULA method is a research method that investigates upper limb disorders. Each motion will be given a predetermined score. RULA was also developed as a method to detect work postures that are a risk factor (Oktaviani et al., 2022). According to Adiyanto (2022), this method does not require special equipment in providing a quick assessment of the posture of the neck, trunk, and upper limbs along with muscle function and external loads experienced by the body. RULA consists of three steps, the results of the RULA work posture analysis consist of four levels of work attitude scales that are dangerous for workers (Micheletti Cremasco et al., 2019; Irmawati & Wahyani, 2024).

REBA (Rapid Entire Body Assessment)

According to Pratiwi (2021), the REBA (Rapid Entire Body Assessment) method is used to calculate and analyze all parts of the human body. By using this method, an assessment can be made by providing an assessment score between risks. If there is the highest score, it can result in a large risk in a job. One of the functions of REBA is to categorize and assess posture risks on all parts of the worker's body (Andriani et al., 2018). The results of the REBA work posture analysis consist of four levels of work attitude scales that are dangerous for workers.

NBM (Nordic Body Map)

According to Dewi (2020), the Nordic Body Map (NBM) is a questionnaire that is most often used to determine discomfort or pain in the body. Respondents who fill out the questionnaire are asked to mark whether there is a disturbance in the body area. NBM is intended to find out in more detail the parts of the body that experience interference or pain while working (Susihono et al., 2020; Dhafir et al., 2024). The Nordic Body Map questionnaire is the most commonly used questionnaire to determine discomfort in workers because it is standardized and neatly arranged. Nordic Body Map is used to determine musculoskeletal disorder (MSDs) complaints felt by workers.

Methods

The location of data collection in this study was conducted at Hang Tuah 5 Sidoarjo High School, which is located on Jalan M Ridwan No.7, Candi Sayang, Candi, Candi, Sidoarjo Regency, East Java 62171. The independent variable in this study is Musculoskeletal Disorder Injury (MSDs), and the dependent variable in this study is Ergonomic Work Posture. In this study, primary data was obtained directly by researchers in the form of information through structured interviews and distributing questionnaires using the Nordic Body Map to Cleaning Service Employees at Hang Tuah 5 Sidoarjo High School.

PEI is a score parameter in work posture assessment included in the OWAS method and integrated with other studies such as RULA and REBA. In the OWAS method and is integrated with other studies such as RULA and REBA. OWAS categorizes work postures into several levels of risk based on the position of the back, arms, legs, and the load being lifted. Position Bending over when lifting gallons usually falls into the high-risk category. RULA focuses on upper body postures (arms, shoulders, wrists) and their its relationship to the activity. Work postures with raised arms, tense shoulders, or wrists in a non-neutral position when lifting gallons will result in a high risk score. REBA analyzes the risk of work postures on the whole body. Lifting gallons with a hunched back, unbent knees, and twisting the body will result in a high risk score. bent, and twisting the body will result in a high risk score.

Results and Discussion

Based on the number of employees available, the worker data used is all cleaning service employees at Hang Tuah 5 Sidoarjo High School. Based on the results of a saturated sample

where all members of the population are used as samples with a total of 10 employees, to ensure the experience of each worker. The following is data on the number of workers who have been collected.

Table 1. Nordic Body Map (NBM) Questionnaire Results

Name	Number of complaints	Type of complaint	Description
AG	13	1,2,3,4,5,6,7,10,11,13, 15, 16,17	5 Somewhat Sick 8 Sick
KK	15	0,1,2,3,5,6,7,11,13,14, 15,16,17,22,23	6 Somewhat Sick 9 Sick
DN	15	1,2,3,4,5,6,7,11,13,14, 15,16,17,24,25	12 Somewhat Sick 3 Sick
DV	15	0,1,2,3,4,5,6,7,11,13, 15,16,17,18,19	10 Somewhat Sick 5 Sick
YD	12	1,2,3,4,5,6,7,14,15,16, 17	8 Somewhat Sick 4 Sick
RN	15	1,2,3,4,5,6,7,10,11,13, 14,15,17,22,23	9 Somewhat Sick 6 Sick
WD	19	0,1,2,3,4,5,6,7,10,11, 13,14,15,17,18,19,20, 22,27	13 Somewhat Sick 6 Sick
DG	17	1,2,3,4,5,6,7,10,11,13, 15,16,17,22,23,26,27	10 Somewhat Sick 7 Sick
LN	13	0,1,2,3,4,6,7,11,12,13, 17,18,19	7 Somewhat Sick 6 Sick
DM	13	1,2,3,4,5,6,7,14,15,16, 17,19,27	8 Somewhat Sick 5 Sick

Source: Primary data

Tabel 2. Calculation Results and Percentage of Nordic Body Map Questionnaire

Type of complaint	Morbidity Rate							
	Not Sick		Somewhat Sick		Sick		Very Sick	
	Amount	%	Amount	%	Amount	%	Amount	%
Pain / stiffness in the neck part on	6	60%	4	40%				
Pain / stiffness in the neck part lower			10	100%				
Pain in the left shoulder			6	60%	4	40%		
Pain in the right shoulder					10	100%		
Pain in the arm on left	1	10%	9	90%				
Pain in the back	1	10%	1	10%	8	80%		
Sick arm on right			6	60%	4	40%		
Pain in the waist			3	30%	7	70%		
Pain in the buttocks	10	100%						
Pain in the buttocks	10	100%						
Pain in the elbow left	6	60%	4	40%				
Pain in the elbow right	2	20%	4	40%	4	40%		
Sick arm lower left	9	90%	1	10%				
Pain arm bottom right	2	20%	2	20%	6	60%		
Wrist pain hand left	4	40%	6	60%				
Wrist pain hand right	1	10%			9	90%		
Pain in the hand left	3	30%	7	70%				
Pain in the hand right			3	30%	7	70%		
Pain in the thigh left	7	70%	3	30%				
Pain in the thigh right	5	50%	5	50%				
Knee pain left	9	90%	1	10%				
Knee pain right	10	100%						
Pain in the calf left	6	60%	4	40%				
Pain in the calf right	7	70%	3	30%				
Pain in the left ankle	9	90%	1	10%				
Pain in right ankle	9	90%	1	10%				

Pain in the left leg	9	90%	1	10%				
Pain in the right leg	7	70%	3	30%				

Source: Primary data

OWAS Calculation

OWAS manual which consists of 4 levels (back, arms, legs and load) with the aim is to show the category of work attitudes that are not ergonomic for cleaning service employees. cleaning service employees. This OWAS calculation is carried out to determine the form of work postures that can cause problems or risk of injury to workers.

Table 3. OWAS Work Action Category for Cleaning Service employees

Back	Arms	Legs																							
		1			2			3			4			5			6			7					
		Load																							
		1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	1	1	1	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	1	1	1
	3	1	1	1	1	1	1	1	1	1	2	2	2	2	2	3	1	1	1	1	1	1	1	1	2
2	1	2	2	3	2	2	3	2	2	3	3	3	3	3	3	2	2	2	2	2	3	3	3	3	3
	2	2	2	3	2	2	3	2	2	3	3	4	4	3	4	4	3	3	4	2	3	4	4	4	4
	3	3	3	4	2	2	3	3	3	3	3	4	4	4	4	4	4	4	4	2	3	4	4	4	4
3	1	1	1	1	1	1	1	1	1	2	3	3	3	4	4	4	1	1	1	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	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	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	4	4	4
	2	3	3	4	2	3	4	3	3	4	4	4	4	4	4	4	4	4	4	2	3	4	4	4	4
	3	4	4	4	2	3	4	3	3	4	4	4	4	4	4	4	4	4	4	2	3	4	4	4	4

Source: Data Processing

In the table above, level 3 results are obtained in the posture of lifting weights, where the category is dangerous to the musculoskeletal system (work posture causes a very significant strain effect) requires immediate improvement.

RULA Calculation

RULA manual which consists of 3 steps (work posture recording, scoring system and action level scale) that must be done in order to know the score obtained. With the aim of showing the category of work attitudes that are not ergonomic for cleaning service employees.

Table 3. RULA Score Measurement in Table A

Table A		Wrist Score							
		1		2		3		4	
Upper Arm	Lower Arm	Wrist		Wrist		Wrist		Wrist	
		Twist		Twist		Twist		Twist	
		1	2	1	2	1	2	1	2
1	1	1	2	2	2	2	3	3	3
	2	2	2	2	2	3	3	3	3
	3	2	3	3	3	3	3	4	4
2	1	2	3	3	3	3	4	4	4
	2	3	3	3	3	3	4	4	4
	3	3	4	4	4	4	4	5	5
3	1	3	3	4	4	4	4	5	5

	2	3	4	4	4	4	4	5	5
	3	4	4	4	4	4	5	5	5
4	1	4	4	4	4	4	5	5	5
	2	4	4	4	4	4	5	5	5
	3	4	4	4	5	5	5	6	6
5	1	5	5	5	5	5	6	6	7
	2	5	6	6	6	6	7	7	7
	3	6	6	6	7	7	7	7	8
6	1	7	7	7	7	7	8	8	9
	2	8	8	8	8	8	9	9	9
	3	9	9	9	9	9	9	9	9

Source: Data Processing

The total score obtained in table A of the RULA worksheet for cleaning service employees who lift goods is 5. Where the value is included in the medium category that needs further investigation. These high scores can lead to an increase in musculoskeletal problems such as chronic back pain or repetitive strain injuries

Table 4. RULA Score Measurement Table in Table B

Neck Posture Score	Table B: Trunk Posture Score											
	1		2		3		4		5		6	
	Legs		Legs		Legs		Legs		Legs		Legs	
	1	2	1	2	1	2	1	2	1	2	1	2
1	1	3	2	3	3	4	5	5	6	6	7	7
2	2	3	2	3	4	5	5	5	6	7	7	7
3	3	3	3	4	4	5	5	6	6	7	7	7
4	5	5	5	6	6	7	7	7	7	7	8	8
5	7	7	7	7	7	8	8	8	8	8	8	8
6	8	8	8	8	8	8	8	9	9	9	9	9

Source: Data Processing

For the total score obtained in table B RULA worksheet of cleaning service employees moving goods is 7. Where the value is included in a very high category that must be investigated and changes made immediately. These high scores can lead to an increase in musculoskeletal problems such as chronic back pain or repetitive strain injuries.

Table 5. RULA Score Measurement Table in Table C

Table C		Neck, Trunk, Leg Score						
		1	2	3	4	5	6	7
Wrist/Arm Score	1	1	2	3	3	4	5	5
	2	2	2	3	4	4	5	5
	3	3	3	3	4	4	5	6
	4	3	3	3	4	5	6	6
	5	4	4	4	5	6	7	7
	6	4	4	5	6	6	7	7
	7	5	5	6	6	7	7	7
	8+	5	5	6	7	7	7	7

Source: Data Processing

The final score in Table C for the work posture of Cleaning Service employees is 7. Based on this score, the risk level of employee work postures is categorized as a very high risk level, further investigation is needed and corrective action needs to b.

REBA Calculation

Manual REBA calculation is carried out which consists of 3 steps (work posture recording, scoring system and action level scale) that must be done in order to know the score obtained. With the aim of showing the category of work attitudes that are not ergonomic for cleaning service employees.

Table 6. REBA Score Measurement Table in Table A

Table A		Neck											
		1				2				3			
		Legs				Legs				Legs			
		1	2	3	4	1	2	3	4	1	2	3	4
Trunk Posture Score	1	1	2	3	4	1	2	3	4	3	3	5	6
	2	2	3	4	5	3	4	5	6	4	5	6	7
	3	2	4	5	6	4	5	6	7	5	6	7	8
	4	3	5	6	7	5	6	7	8	6	7	8	9
	5	4	6	7	8	6	7	8	9	7	8	9	9

Source: Data Processing

For the total score obtained in table A REBA worksheet for cleaning service employees moving goods is 6. This value is categorized as a moderate risk level that needs improvement. These high scores can lead to an increase in musculoskeletal problems such as chronic back pain or repetitive strain injuries

Table 7. REBA Score Measurement Table in Table B

Table B		Lower Arm					
		1			2		
		Wrist					
		1	2	3	1	2	3
Upper Arm Score	1	1	2	2	1	2	3
	2	1	2	3	2	3	4
	3	3	4	5	4	5	5
	4	4	5	5	5	6	7
	5	6	7	8	7	8	8
	6	7	8	8	8	9	9

Source: Data Processing

For the total score obtained in table B REBA worksheet for cleaning service employees moving goods is 5. This value is categorized as a moderate risk level that needs improvement. These high scores can lead to an increase in musculoskeletal problems such as chronic back pain or repetitive strain injuries.

Table 8. REBA Score Measurement Table in Table C

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

	7	7	7	7	8	9	9	9	10	10	11	11	11
	8	8	8	8	9	10	10	10	10	11	11	11	11
	9	9	9	9	10	10	10	11	11	11	12	12	12
	10	10	10	10	11	11	11	11	12	12	12	12	12
	11	11	11	11	11	12	12	12	12	12	12	12	12
	12	12	12	12	12	12	12	12	12	12	12	12	12

Source: Data Processing

The final score in Table C for the work posture of Cleaning Service employees is 10. The final REBA score is 11, due to the addition of the instability muscle activity score. Based on this score, the risk level of the employee's work posture is categorized as a high risk level, further investigation is required and corrective action needs to be taken.

PEI calculation

The PEI value is done first by analyzing OWAS, RULA and also REBA. After getting the score from each method, the next is the PEI analysis. Where in this analysis the value of each method will be combined to get the PEI score with the following formula:

$$PEI = I_1 + I_2 + (I_3 \times mr)$$

Where

$$I_1 = \frac{OWAS}{4} + I_2 = \frac{RULA}{7} + \left(I_3 = \frac{REBA}{15} \times 1,42 \right)$$

- $I_1 = \frac{OWAS}{4} = \frac{3}{4} = 0,75$
- $I_2 = \frac{RULA}{7} = \frac{7}{7} = 1$
- $I_3 = \frac{REBA}{15} \times 1,42 = \frac{11}{15} \times 1,42 = 1,041$

After obtaining the value of I_1 , I_2 , I_3 then the PEI calculation will be carried out:

$$PEI = I_1 + I_2 + I_3$$

$$PEI = 0,75 + 1 + 1,041 = 2,791$$

$$PEI = 2,791$$

After calculating the value of (PEI) Posture Evaluation Index , a value of 2.791 is obtained. Because the PEI value is in 2.6-3.42 then, the maximum value of PEI is high category and improvements must be made immediately in the workplace area. There are risk factors that cause musculoskeletal system problems, namely excessive muscle stretching, repetitive activities and unnatural posture of workers.

Proposed Improvements

Based on the proposed improvements to the work posture of the Cleaning Service when lifting gallons/objects with proposed improvements to the position of the Back (trunk) angle of 0°-20°, the position of the Neck (neck) angle of 0°-20°, the Leg Position (Legs) rests on both legs and is bent, the position of the Upper Arm (Upper Arm) angle of 20°-45°, the position of the Lower Arm (Lower Arm) angle of 60°-100°, and the position of the Wrist Movement (wrist) angle of 0-15°. With the results of the proposed improvements to the body position, it will get a lower risk value than before and the value that is at 0.4-2.5 will show a good work

posture so that employees avoid musculoskeletal injuries so that employees can work optimally. Procurement of assistive devices such as the use of trolleys or transporters to reduce the frequency of manual lifting.

Conclusion

Based on the results of data processing calculations of the Nordic Body Map (NBM) questionnaire results, with a total of 10 employees in lifting gallons / goods obtained complaints that can be known to be unergonomic work postures. Based on the results of data processing calculations, the OWAS score is 3, the RULA score is 7 and the REBA score is 11. Then the PEI calculation is carried out by entering the score of the OWAS, RULA and REBA calculations and the results obtained are I1 of 0.75, I2 of 1 and I3 of 1.041. And this value is included in the category of maximum PEI value in the high category and must immediately make improvements to the workplace area. The risk factors that cause musculoskeletal system problems are excessive muscle stretching, repetitive activities and unnatural postures of workers. With the results of the proposed improvements to the body position, a lower risk value will be obtained than before and a value that is at 0.47-2.5 will indicate a good work posture so that employees avoid musculoskeletal injuries so that employees can work optimally.

Suggestions for reducing musculoskeletal injuries in Cleaning Service employees at Hang Tuah 5 Sidoarjo High School. Procurement of assistive devices such as the use of trolleys or conveyances to reduce the frequency of manual lifting. Rotate the jobdesk of cleaning service employees to reduce idle time. Pay attention to the application of K3 to employees and the need to pay attention to ergonomic work postures. It is recommended that further research can pay attention to the influence of age, height and length of service.

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