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Ergonomic Posture Assessment Approaches for New Welder: A Study in Technical Institution

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ABSTRACT

Welding practical work is a compulsory learning process for all mechanical engineering students in Malaysian polytechnics, students will spend 2 to 4 hours a week doing practical work. Because of that, this situation can cause problems for students when performing tasks, including body posture and manual handling during practical work which can result in musculoskeletal disorders (MSD), in addition non-standard instructions for performing tasks also happen. This study aims to identify the risk of postural problems during welding practical work and suggest an appropriate ergonomic posture assessment to reduce the risk of MSD. In order to assess the position of body posture during welding practical work at technical education institutions, the Rapid Upper Limb Assessment (RULA) and Rapid Entire Body Assessment (REBA) tools were used to observe body posture during practical work and specifically to see the bending level of body parts during work welding practice. Analysis and evaluation were carried out using REBA and RULA and found that the final score for RULA was at a value of 7 and the score for REBA was 9 in the same welding practical. Based on these two scores it was found that welders are at high risk to getting cumulative trauma disorder (CTD) which can also result in MSD. In conclusion, both REBA and RULA body posture assessment tools can be used to assess body posture when carrying out practical work, however, REBA is more suitable because there is an assessment of the leg part which usually involves the leg part while welding, either standing, sitting or squatting. (CTD).

Keywords: Ergonomics, musculoskeletal disorders, ergonomic posture assessment, RULA, REBA, welding practical work.

INTRODUCTION

The relationship between employees and workplace factors, such as machinery or the workplace environment, is defined as ergonomics (Najihah et al. 2020). Working posture issues, such as musculoskeletal diseases (MSD) and cumulative trauma disorders (CTD), are mostly prevalent in both developed and developing nations (Al Madani & Dababneh 2016). Repetitive work, uncomfortable working postures, and difficult working environments are the major causes of working posture difficulties (Sanmugum et al. 2020). A lengthy static body postural position, awkward body posture, and fume exposure were all common occupational risk factors throughout the welding process (Suman et al. 2020). These ergonomic risk factors contribute to MSD related to welding activity. Musculoskeletal disorders is an injury and disease influenced by muscle, nerve, tendons, ligament, blood, and bone tract (Silverstein et al. 1986).

MSD is defined as a health concern caused by a high-intensity task that affects the ligaments, tendons, bones, and muscles (Goodman et al. 2012). Workers with MSD should get treatment right once since it can develop to serious health problems including paralysis and mobility difficulties (Al Madani & Dababneh 2016). MSD encompasses all musculoskeletal injuries, including bones, muscles, and ligaments, caused by overexposure to the

occupational risk factors and hazards (Dev et al. 2018). Previous study shows that MSD were caused by poor workspaces and manual handling of equipment, forcing the worker to adapt to poor working conditions (Mukhopadhyay & Khan 2014).

CTDs are health problems in which the muscles and tendons are constantly 'wearing out,' preventing the damage from healing(Kroemer 1989). CTD is mainly induced by holding a static work position for an extended amount of time. Repetitive labour, excessive vibration, restricting work posture, and intense motions induce discomfort, impairment, and pain in muscles, tendons, and tissues, which are classified as CTD (Vinay 2017). CTD often affects the upper body, particularly the wrists. CTD of the hands and wrists is frequently induced by repeated and strenuous tasks (Silverstein et al. 1986). CTD can be categorised as a chronic injury induced by a significant load or force that develops gradually over time, according to the findings of Mahoney study (Mahoney 1995).

Based on statistics from the Department of Occupational Safety and Health, Ministry of Human Resources, an increasing number of MSD cases in Malaysia have been reported, from 188 cases in 2018 to 237 in 2020 (DOSH (Department of Occupational Safety and Health) 2020). Thus, the objective of this study is to identify and analyse the differences of proper ergonomic welder posture using the Rapid Upper Limb Assessment (RULA) and Rapid Entire Body Assessment (REBA) analyses. RULA and REBA are observation-based techniques used to quantitatively measure human posture and assess complaints and postural stresses due to poor posture.

TABLE 1. Previous studies on RULA and REBA

Author/ Year	Method	Sector/Country	Objectives/aims	Result/Findings
Mukhopadhyay & Khan 2014	REBA	Food Industry/ India	Repetitive task specifically in mincing process using meat cutters	The results suggest that the meat cutter has a significant risk of injury due to repetitive work for lengthy periods of time each day.
Vinay 2017	RULA and REBA	Clothing Industry/ India	Analyse working task of sewing, ironing and cutting for males' tailor	According to RULA's findings, 40% of tailors are at risk of MSD during cutting, 55% while sewing, and 65% while ironing. Cutting activities suggest that 5% of REBA employees are at risk for MSD, 35% for sewing, and 30% for ironing.
Motamedzade et al. 2011	REBA	Engine Oil Company/ Iran	Analyse only one task for 40 jobs scopes	The findings revealed that the risk of work posture problems is low to moderate.
Ansari & Sheikh 2014	RULA and REBA	Manufacturing Industry/ India	Analyse 15 individuals with various job duties	According to the findings, RULA estimates that 40% of employees are at higher risk of MSD, whereas REBA estimates that 53% of workers are at higher risk of MSD.
Wanave et al. 2014	RULA	Manufacturing Industry/ India	Assessment of workers' workstations	The RULA assessment score is a 5. It demonstrates that with immediate modifications, further study is necessary.
Norhidayah et al. 2016	RULA and REBA	University Personnel and Office Workers/ Malaysia	Analyse workers posture and workstations to give knowledge for future ergonomic computer workstation design.	The analysis of RULA receives an average score of 5, whereas REBA receives an average score of 4.
Sutari et al. 2015	RULA	Batik Stamp Industry/ Indonesia	Identification of muscle or bone tissue disorder based on the results from RULA's findings.	The RULA score of 6 indicates that employees are at a moderate to high risk of MSD.
Md Hashim & Zawiah Md Dawal 2013	RULA and REBA	School Workshop/ Malaysia	Analyse 93 different work postures on secondary school students from age 13 to 15.	The average RULA score is 4.87, while the average REBA score is 5.87. This indicates that the danger of a work posture problem is moderate, and that additional action is required.

Ergonomics is distinguished as the study of the relationship between workers and their work environment (Nadu 2018). Precisely, ergonomics is about creating a work environment more compatible with workers, rather than forcing workers to physically adapt to the work environment(Vinay 2017). Physical work can expose oneself to the symptoms of Work Musculoskeletal Disorder (WMSD) such as Carpal Tunnel Syndrome (CTS) or Lower Back Pain (LBP) (Thiruchelvam et al. 2021). An ergonomic work posture is crucial because it can decrease the risk of injury from inadequate task conditions. Poor work postures are frequently connected with repetitive work, stress, tension, continual force, and excessive vibration, according to the Ontario Occupational Safety .(and Health Council (OHCOW 2016

The RULA is an ergonomic examination method used to assess the risk of posture problems at work, particularly MSD. The RULA was designed to be an objective measure of MSD risk during work hours(Mahoney 1995). It is based on an evaluation of postural problems such as static movement, repetitive work, external forces with the duration of work in relation to arms, trunk, neck, legs and wrists (Mcatamney & Corlett 1993). Measurement of score in a RULA analysis involves observation of four action which are arm, risk, neck and trunk also leg

To analyse body parts and posture problems at work, REBA and RULA use the same principle of posture analysis at work (Hignett & McAtamney 2000). Parts of the body are separated into sections in a REBA study, and the score is derived using levels of movement and muscle activity (Al Madani & Dababneh 2016). Joint angle measurements, force or load observations, repetition of movement, and frequency of posture changes are among the five action levels used to calculate the score.

The primary distinction between RULA and REBA is in the work or activity analysis. The REBA is a more efficient assessment for the service sector, according to the findings of this study. In contrast, the RULA solely focuses on the upper body, while the REBA examines the entire body. As a result, the RULA is better suited to sedentary and sedentary work analysis, whereas the REBA is better suited to static and dynamic work analysis. This study performed direct surveillance; goniometer measurement on students during practical work; RULA and REBA questionnaires; interviews and photographs; and assessment of ergonomic risk factors. The result demonstrated that posture analysis revealed a significant risk, particularly for the meat grinder task, indicating that additional research is needed for control measures to reduce the risk factors.

Currently, REBA has not specifically conducted for technical students who performed welding during their practical work at educational institution in Malaysia. Nevertheless, an assessment of ergonomic risk factors has been performed among professional welders among which aims to examine the type and extent of weapons of mass destruction in new welders (Salami Ismaila et al. 2011). Table 1 summarizes previous studies on work posture involving RULA and REBA analyses in different industries.

METHODOLOGY

To assess risk factors for MSD and CTD, an observational approach is widely used to examine the ergonomics of work position. RULA and REBA were used for this study to examine the new welders' work postures. Worksheets and goniometers were used to record the amount of body flexion during the RULA and REBA analyses. In this investigation, 15 samples are gathered. As new welders, 15 students complete practical work and assess their ergonomic posture. In order to record the best posture from the new welder, the direct observation approach is used.
The RULA approach was developed by Mc Atamney and Corlett in 1993. The RULA is a posture assessment approach for determining the risk of upper limb injury from working position. The RULA worksheet is known to focus on examining posture, job repetition, and force exerted during perform task (Mcatamney & Corlett 1993). The study is separated into two sections: Section A examines the arms and wrists, while Section B examines the neck, chest, and legs. A RULA score is calculated based on these analyses to assess the hazards of poor pos-.ture at work

The RULA worksheet is used to examine work posture risk factors that might influence the body, including the upper arms and lower arms, such as mobility, exertion, repetitive activity, and work posture. The forearms, wrists, neck, chest, and legs are all affected. Table 2 shows the processes for analysing work posture using the RULA worksheet. The RULA worksheet is a data analysis tool that includes of scoring judgments that are used to assess workplace posture concerns. RULA's colour coded rating choices are shown in Table 3. A work posture score of 1 to 2 is considered satisfactory. Values of 3 to 4 and 5 to 6 suggest a low and medium risk of work-related posture issues, respectively. Additionally, further study is needed to identify the true extent of workplace posture issues. Finally, a score of 7 or above suggests a higher likelihood of developing postural issues.

TABLE 2. Steps of RULA assessment method

Steps	Descriptions	Analysis
1	Upper Arm Position	
2	Lower Arm Position	
3	Wrist Position	
4	Wrist Twist Position	Arm and Wrist Analysis
5	Calculate Posture Score A	
6	Add score for Muscle Use	
7	Add Score Force/Load	
8	Neck Position	
9	Trunk Position	
10	Calculate Legs Condition	Neck, Trunk and Leg Analysis
11	Calculate Posture Score B	
12	Add Score Muscle Use	
13	Add Score Force/Load	
14	Find Column in Posture Score C according to score A and B	
15	Determine Final Score for RULA	

TABLE 3 RULA score decision

Score	Level of MSD Risk	Action Level
1 or 2	Negligible risk	Acceptable posture
3 or 4	Low risk	Need further investigation and modification may be needed
5 or 6	Medium risk,	Need further investigation and modify immediately
7	Very high risk	Investigate and implement modification

In the year 2000, Hignett and Mc Atamney established the REBA technique of analysis. The REBA is a type of ergonomic posture assessment that examines the complete body for risk factors connected to work posture. The REBA analysis worksheet is used to evaluate work posture, including body position, movement, force exerted, and task repetition. The neck, chest, and legs are covered in Section A, while the arms and wrists are covered in Section B.

The working posture problem risk variables for movement, exertion force, repetitive labour, and work posture were examined using the REBA worksheet. Table 4 shows the procedures taken to analyse the working posture using the REBA worksheet. The REBA worksheet was used to examine risk factors for work posture issues involving mobility, stress, repetitive tasks, and work posture.

TABLE 4 Steps of REBA assessment method

Steps	Descriptions	Analysis
1	Neck Position	
2	Trunk Position	
3	Legs Position	Neck, Trunk and Legs Analysis
4	Calculate Posture Score A	
5	Add Score Force/Load	
6	Upper Arm Position	
7	Lower Arm Position	
8	Wrist Position	Arm and Wrist Analysis
9	Calculate Posture Score B	
10	Add score for Coupling Score	
11	Add Activity Score	
12	Determine Final Score	

Making judgements while identifying the hazards of workplace posture disorders is the goal of REBA data analysis. REBA's score decision is shown in Table 5. A score 1 indicates that there is no danger. Low risks are indicated by a score of 2 or 3, while medium hazards are indicated by a score of 4 to 7, indicating that additional research and necessary modifications are required. A score of 8-10 indicates a higher risk, necessitating further analysis and solution execution. Finally, a score of 11 or more indicates a very high risk, with the adoption of a remedy or proposal being required.

TABLE 5 REBA score decision

Score	Level of MSD Risk
1	Negligible risk
2 or 3	Low risk, modification may be needed
4 to 7	Medium risk, further investigation, modified immediately
8 to 10	High risk, investigate & implement modification
11+	Very high risk, implement change

RESULTS AND DISCUSSION

The upper arm, lower arm, and wrist postures are examined in Section A. Figure 1 displays the RULA analysis for the upper arm (a), lower arm (b), and wrist (c) based on the angles determined from body position.

The examination of a welder's body posture is shown in Figure 2, which comprises estimating the angles of the body posture for the neck (d) and trunk (e). The RULA worksheet focuses on the body posture of the neck, trunk, and legs in part B.

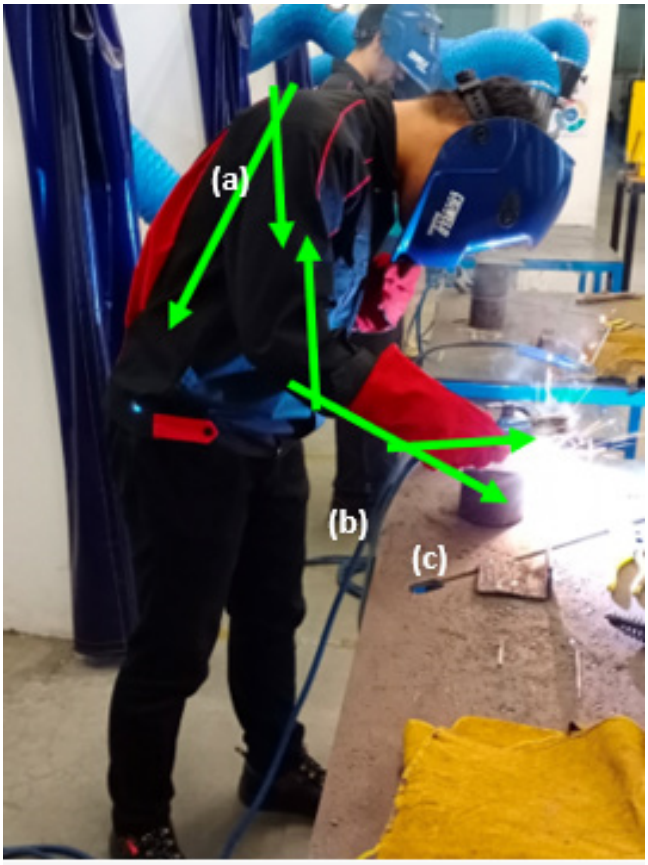

FIGURE 1 Upper arm, lower arm, and wrist analysis for RULA.

FIGURE 2. Neck, trunk, and leg analysis for RULA

The findings of an ergonomic risk assessment utilising the RULA evaluation are shown in Table 6. The average score for Section A analysis, which includes upper and lower arm position, wrist score, and wrist twist score, is determined to be 4. Analysis for each part by comparing to RULA table A, where score 2 is for upper arm position, 3 for lower arm position, 3 on wrist, and 1 for wrist twist score. A score 1 point is given for muscle use and 2 points is given for the weight of the welding torch, which ranges from 4.4 - 22 pounds. So total score of 7 for RULA analysis for Section A is calculated

TABLE 6 Results of RULA assessment.

	RULA Assessment																		
	Section A: Arm and Wrist Analysis								Section B: Neck, Trunk and Leg Analysis								RULA FINAL SCORE(Refer Table C)	RISK LEVEL	ACTION LEVEL
Job/ Tasks	Upper Arm Score	Lower Arm Score	Wrist Score	Wrist Twist Score	POSTURE Score A(Refer Table A)	Muscle Use Score	Force / Load Score	Wrist & Arm Score	Neck Score	Trunk Score	Leg Score	POSTURE Score B(Refer Table B)	Muscle Use Score	Force / Load Score	Neck, Trunk & Leg Score				
Average of 15	2	3	3	1	4	1	2	7	3	3	2	5	1	2	8 (7+)		7	Very high risk	Implement change now

Section B deals with the analysis of the body part of the torso and the leg. The score for the neck is 3, followed by a basic score of 3 and the final score for the leg is 2 because the leg and feet are not supported by any other material. Cross-checking for neck, torso, and leg in RULA Table B results in a value of 5. This is followed by 1 for the muscle used and 2 for the welding torch load source. This results in the overall Section B is score 8.

The RULA analysis value for this practical welding work activity refers to the RULA Table C with score value 7. On the RULA scale, the 7 values signify a very high risk and should investigate and implement any modification to the current control measures during welding activity.

The study of the neck and torso postures is covered in Section A. The REBA analysis is depicted in Figure 3 using the angles acquired from the neck (a), torso (b), and leg (c) postures. The REBA worksheet analysis based on the data in Figure 4 is shown in Table 7.

The study of the neck and torso postures is covered in Section A. The REBA analysis is depicted in Figure 3 using the angles acquired from the neck (a), torso (b), and leg (c) postures. The REBA worksheet analysis based on the data in Figure 4 is shown in Table 7.

FIGURE 3. Neck and trunk analysis for REBA

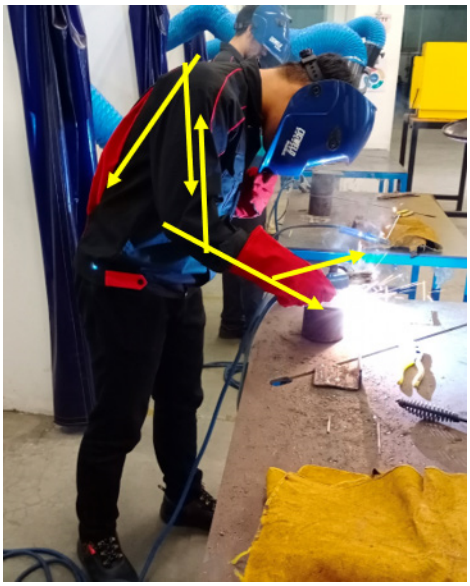

FIGURE 4. Upper arm and lower arm analysis for REBA

The upper arms, forearms, and wrists are the subject of Section B of the REBA worksheet analysis. Figure 4 depicts the welder's posture analysis approach, which includes determining the angle of each posture using the upper arm (d), forearm (e), and wrist (f).

The findings of the ergonomic risk assessment based on the REBA evaluation are shown in Table 7. The average score for the analysis of Section A, which includes the neck, trunk, and leg of the cross check using REBA Table A and the outcome, is 6, with a score of 3 for the neck position, 3 for the body position, and 2 for the leg, respectively. If the welding torch weighs less than 4 kg, the load weight can be ignored.

TABLE 7. Scores from REBA assessment

Job/ Tasks	REBA Assessment																	
	Part A: Neck, Trunk and Leg Analysis						Part B: Arm and Wrist Analysis											
	Neck Score	Trunk Score	Leg Score	POSTURE Score A (Refer Table A)	Force / Load Score	SCORE A	Upper Arm Score	Lower Arm Score	Wrist Score	Wrist Twist Score	POSTURE Score B (Refer Table B)	Coupling Score	SCORE B	SCORE C (Refer Table C)	Activity Score	REBA FINAL SCORE(Score C + Activity Score)	RISK LEVEL	ACTION LEVEL
Total average of 15	3	3	2	6	0	6	3	1	1	1	4	2	6	8	1	9	High risk	investigate & Implement change

In Section B, arms and wrists, the upper arms have a value of 3, the forearms have a value of 1, and the wrists have values of 1 and addition of 1 score to the crooked wrist. In REBA Table B, a cross check for arm and wrist yields a value of 4. This was followed by two more work coupling assessments for a clumsy hand situation, but it could still work. This results in a total score of 6 for the Section B evaluation.

For this actual welding task, the REBA analytical assessment relates to REBA Table C, which yields an evaluation value of 8. For 1 minute of static posture, however, a value of 1 must be added. This results in a final grade of 9, indicating that this is a high-risk posture. A mean of 9 points on the REBA scale indicates an improvement in postural posture. Students are exposed to dangers associated to work posture, according to an ergonomic risk assessment. As a result, it's best to keep the pose's posture and length under control.

Rapid Upper limb Assessment or RULA is a postural analysis tool to assess required posture, strength, and repetition. Based on the ratings, points are entered for each body region in Section A for the arm and wrist and Section B for the neck and torso, respectively. While REBA is a tool to assess posture, effort, type of movement or action, repetition, and engagement. This tool is assigned for each of the following body regions: wrists, forearms, elbows, shoulders, neck, torso, back, legs, and knees.

The REBA score was more detailed than the RULA score, although there were no significant differences in the result of the analysis. According to the REBA and RULA assessment tools, they also include a lower limb posture stress assessment. REBA was created as a method to analyse work postures that are sensitive to musculoskeletal hazards in a range of occupations, and RULA is widely utilised in numerous research. When necessary, REBA is also utilised to validate work postures (Susilowati 2017). The study also reported differences in cognitive complaints because RULA did not sufficiently discriminate lower limb postures, which is in line with the current study, which showed that agreement between expert and RULA ratings for lower limb postures.

During neck and body part assessment, RULA starting scores on 0 - 10˚ bending is 1, but for REBA score 1 refer to no bending neck. When assessing trunk position, RULA did not access for body extension, while REBA will have extra score for body extension and in this study the result shows score of 2. In the case of the legs, RULA only assesses whether they provide support or not, but REBA

assesses the position of the legs when standing in boots. For 2-legged foot or leg curl, a flexion angle of approximately 30° and more than 60° out of flexion angles were identified. Then the last score, RULA starts assessed for normal load score with loads less than 4.4 lbs, but with the same load, REBA gives score less than 11 lbs. The normal stress rating in this assessment is given as 0.

For the wrist body part, 0° for RULA refers to a score of 1, but unlike the REBA score of 1, it refers to wrist flexion around 15° and +15°. For this part, RULA only evaluates to locate the position of the forearm across the center line of the body.

Finally, based on Table 3 and Table 5, RULA categorized the score decision into four part which is negligible risk, low risk, medium risk, and very high risk. On the other hand, REBA uses five part of score decision namely negligible risk, low risk, medium risk, high risk, and very high risk. Overseeing that REBA approach is more convenient for the assessment of full-body work postures than other assessment instruments(Hita-Gutiérrez et al. 2020).

CONCLUSION

In this study, the working postures during the welding process were analysed during practical work at the technical institute. The welder's working posture was examined using the RULA and REBA method analysis and both findings were compared.

Based on this study, approaches using RULA and REBA tools, showed an increased risk for posture problems at work for welders, such as MSD and CTD. According to the RULA analysis, the welding process score during practical work is 7. This indicates that the welding process presents a very high risk of posture problems at work that must be given attention to apply the control measures appropriately. However, the REBA score was 9 for the same activities, which means a very high risk and should require immediate action during the activity in terms of elimination of the hazard.

Ultimately, based on the RULA and REBA score in this study, there are no significant differences between the action values of REBA and RULA. Both REBA and RULA thus fulfill the requirement to carry out an ergonomic posture assessment during welding work. However, the most appropriate way to perform an ergonomic posture assessment is the REBA assessment, as it provides a broader element of access to postures, including flexing the feet and positioning of the legs during welding posture.

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DECLARATION OF COMPETING INTEREST

None.

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