

RISK ASSESSMENT FOR STANDING WORKBENCH POSTURE IN WELDING PROCESS: A CASE STUDY OF UiTM TERENGGANU

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ABSTRACT

Welding requires 'hands-on', work intensively, practice for months and years to get at the craft. Not only from skill standpoint, but welding takes its toll on the human body. The aim of this assessment is to assess the working positions of students learning workshop activity for welding at workbench, that labeled as awkward and high risk which contributing to body pain. Therefore, ergonomic assessment (REBA) for welding posture can become a key in preventing body pain while weld. There is five steps for conducting Ergonomic Assessment; review from previous researcher regarding standing position to weld; Selected tools, Rapid Entire Body Assessment (REBA) determine the score based on posture evaluated, force requirement, type of movement and coupling observed within task; Gather subjective data (workshop environment, involving the student):Gather objective data (develop prioritize weld activities) and risk factors; and lastly Analyses all data and identify risk reduction opportunities as well as identify potential injury and severity. The observation and posture analysis strongly reveal back pain and fatigue due to awkward posture (standing for quite a time). Overuse of muscle closed related to welding activities which frequent and repetitive. Work related musculoskeletal disorders depending on workplace elements, technique of welding and environment factors.

Keywords: Awkward Posture, Ergonomic Assessment, Welding Position, Back pain

1. INTRODUCTION

Welding position happen when a process of connecting between two pieces of metal together. Depending on the industry, the welding process can become extremely difficult (out of position and limited access). They are many welding processes and metals. For welding position are closed related to type of welding. Some welding process can generally use in every position if used consumable electrode for the filler metals. For this type of welding condition can be used outside and in windy environments. Shield metal arc welding (SMAW), commonly used as teaching method for student in workshop welding learning. It has all variable of any welding technique, which is why SMAW is a manual welding process. The variable includes electron selection, atmosphere, position, amperage, voltage, parent metal alloy, parent metal thickness as well as ambient temperature. Why this SMAW are commonly selected as teaching aid in welding because of easy to learn, can work in open air or field condition and has more variety in terms of different specifications.

REBA is a visual observation worksheet as the primary means of measurement body position while working against body movements in assessing Musculoskeletal Disorder Pain as well as to identify workplace injuries. The use of REBA in assessing workplace ergonomic risk, as well as seeking preventive measure for awkward positions in welding workers is necessary. The selection of job position for analysis is based on observation that contributes to discomfort. Each ergonomic assessment risk has relational criteria for assessing complex muscle load, where it depends on the position of the person body, the force acting, and the time taken to complete each task. Important core element of evaluation on each method assessment is based on the objective measure. In conclusion, Rapid Upper Limb Assessment (RULA) and REBA both can assess the overall load for the limb, so is Ovako Working Posture Analysis System (OWAS) for static load. These three methods that most

often used to evaluate job/ task positions where it allows to identify physical outcomes. To the advantage, REBA is more useful for reducing the risk associated injuries with work [1].

Awkward posture and positioning for welding, a bent body needed where a body position deviates from the original (neutral) position. The position of a human body plays an important role in daily life. When the body position classified as an awkward posture, one of the bad effects is it blocks the system digestion which can affect the emotions of the human, in turn affecting the job performance and eventually adding stress while doing the task/ activities. Awkward position also makes possible body become heavier or thicker. According to [Sarkar et al., 2016] the process of formation muscle pain and disease from awkward position can be from the nature of the work, the used of tools and equipment as well as workstation that is not suitable. This awkward posture and position will lead to the use of small group of muscle which contribute to overuse and stretch result in fatigue and pain.

Repetitive movement, from work or activity is another factor to be on looked after. There are several injury terms used to describe risk repetition movements that cause muscle pain: recurrent stretch/stress/ pressure injuries and risk of trauma. This repetitive movement can cause temporary or permanent damage that gives impact on high treatment cost. Repetitive movement are close related to operational time, refer from [2], the pain can be form by adding the repetitive movement from one task at one time to complete, as the heal time are not enough result in fatigue and tension of the muscle.

2. LITERATURE REVIEW

Welding goal for engineering is to safely use arc welding equipment, the student able to produce finished welded joints to an acceptable standard, be able to select the correct welding equipment settings as well as selection of correct consumable and lastly be able to recognize weld associated faults and make suitable corrections where possible. Observed from literature Table 1.0 summarized of selected research regarding welding, that most of past researcher point out that the position of welding can be classified as an awkward posture. Others factor that can be related to contribute high risk of muscle pain from awkward posture while weld, is time completion, repetitive movement, tools, and equipment used and static position at one time. Result from frequent awkward posture can develop muscle pain, the worst case is to develop musculoskeletal disorder. This type of disease can affect daily life and can become a long-term health effect.

Ergonomics comes from the Greek word; ergon is work and nomos is nature of rule. It is a scientific discipline concerned with understanding interactions between humans and elements in other systems. A statement which involves the theories applied, principles, data, and methods to form to optimize human well-being and the performance of the overall system. The main goal of ergonomics is to adapt a job to the employee. Ergonomic assessment method equipment can be divided into external load assessment (working position and applied force), or internal load (body temperature, heart pressure rate and blood pressure). External loads produce internal loads at where it depends on the characteristic of the human (worker) and the type of job, which depend on the capacity of each worker. There are a few ergonomic risk methods, as a tools to overcome the problem and identify severity of the welding process weld position and posture. Table 2.0 shown a summary of types of ergonomic risk assessment tools in the workplace.

Table 1: Summary of past researcher for welding process

Author	Years	Result / issues
Suroso, B., & Prastike, F	2020	The results showed that 5 out of 8 work flow processes have RULA scores with severe and very western risk level, which means that it is necessary to change work postures as soon as possible or as soon as possible
Zhang, Y., Wu, X., Gao, J., Chen, J., & Xv, X	2019	Welders should not use a welding torch with a weight of more than 6 kg when standing up. Secondly, for adult males in the 5th, 50th, 95th percentile of body size, the best operating distance is 321 mm, 371

		mm, and 421 mm, respectively, and the best operating height is 1050 mm, 1100 mm, and 1150 mm, respectively. The horizontal and vertical rotation angle of the welder's neck should not exceed 15° and 8.7
Ariyanti, S., Widodo, L., Zulkarnain, M., & Timotius, K.	2019	That welding work requires tools such as welding stations by adjusting the body posture of the worker. With a new welding workstation, poor working posture can be reduced.
Yusop, M., Mat, S., Ramli, F. R., Dullah, A. R., & Khalil, S. N.	2018	The static posture and muscle pain due to the weight and long welding time. Students need to bend their body and hold the welding tools during welding processes
Baek, S. Y., & Nam, J. H.	2021	Found that external factors such as work preparation or quality-control issues other than the working posture were included, and Welding often requires an unfavourable posture owing to high temperatures, obstruction of vision, or poor working conditions
Matthys, H	2021	Reduction of workstations lead to a reduction in risk score of body movement (KIM-BM) and awkward body postures (KIM-ABP), but the intensity of the physical load stayed the same. To reduce the intensity of the physical load and the time spent in awkward body postures adjustments of the selected workstations were needed.
Kim, J. H., & Nam, J. H	2021	welding man-hours are greatly affected by working position. welding operation has difficulties in image interpretation because an external obstacle caused by arcs exists. Based on the standing position, a different position is determined whenever the positional relationship of the six joint coordinates changes (neck, head, hand (left and right), waist, shoulder
Dinakaran, D., Balasubramanian, K. R., Sivapirakasam, S. P., & Gopanna, K	2019	From the different kinds of working posture at flux Core Arc Welding, the working posture in awkward condition are originate to the occupational perils.
EL-Maturity, H. J	2020	the work posture including work attitude is not ergonomically formed that which makes several parts of the worker's body tired and painful
Susihono, W., Selviani, Y., Dewi, I. A. K. A., & Liswahyuningsih, N. L. G	2020	33 workers have complaints about muscle parts, which are commonly referred to musculoskeletal complaints

Table 2: Summary of types of ergonomic risk assessment tools in the workplace

Ergonomic assessment tools	Assessment (body)	comment
OWAS	Upper body and lower, hands and neck	The basic concepts have been incorporated in other posture analysis systems such as RULA, REBA
RULA	Upper body	
SI	Hands, wrist, arms, elbow	Limited to assess risk on the finger and hand
REBA	Entire body	
LUBA	Upper body	
KIM	The overall physical workload of the limbs	Movement, pressure, force on posture, not all physical workloads listed (workstation evaluation)
ULRA	Upper body	
OCRA	Elbow, wrist, hands	
NIOSH	Lifting /	

Incident and accident at workshop are high, reported by Department of statistic Malaysia [3]. Occupational accident contributes 32,674 cases and manufacturing sectors is the most severe with 10,303 case number of accident at workplace. From previous researcher, welder posture and position considered as awkward. This paper aims to identify the cause of muscle pain and fatigue amongst student that go through welding process in workshop. The workshop was run for 3 hours at one session. The process involves in welding activities are clean, clamp the work close to the weld, insert electrode into insulated holder, set amperage at level recommended, determine the best arc length, use chipping hammer to remove slag and work in standing position (static) at the workbench

Long term goal, the important to recognized and identify risk of muscle pain and fatigue for welding process is to prevent MSDs amongst students. How much severity and prevalent of the muscle pain from the welding activities each semester can happen, and what are the factors that contribute to the risk of muscle pain. To stand in neutral body position with un awkward posture that requires no stressful angle and contact with hard floor while participating in welding process. To be aware of body stretching movement due to long hour training time in static (standing) position to avoided fatigue.

3. RESEARCH METHODOLOGY

The used of REBA ergonomic assessment method to identify awkward posture and recommended change can be determined. The welding workshop at the education institution in Malaysia provide a standing workbench as shown in Figure-1. To perform the welding task, the student needs to bend a little and standing for quite some's time to complete the task. During observation, after finish one task student were told to be uncomfortable and the heats hits them to perform well during the tasks. The student needs to hold the welding tools in one hand, while safety another hand needs to hold the shield mask. There is no arm support provide during the process.

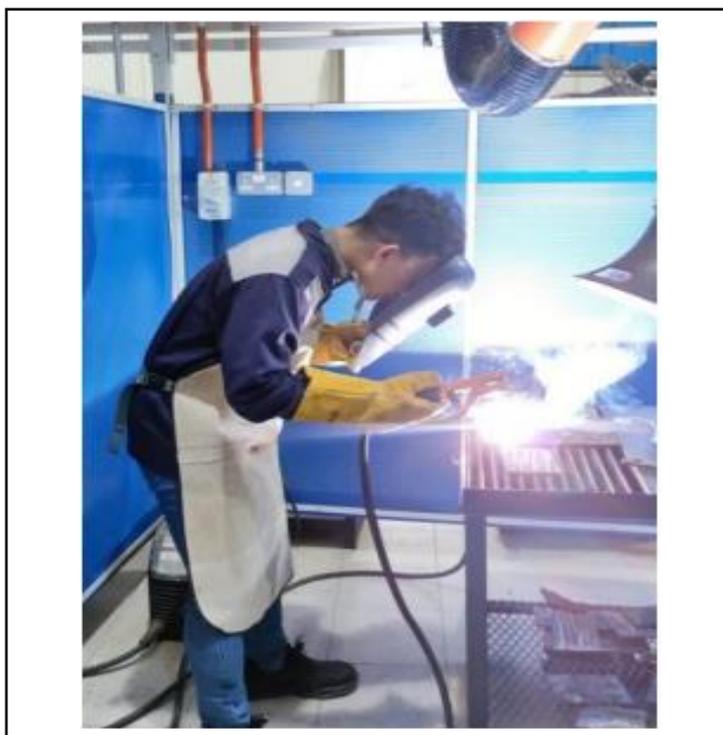


Figure 1: Standing workbench; welding process

Both upper and lower parts of the body can be assessed rapidly with REBA tools. The flow to conduct REBA is listed as below:

- i. Determine body position selections (refer Figure 1)
- ii. Using the REBA, analyses neck, trunk, and leg.
- iii. Determine the force/ load for each task. (Shock force, rapid buildup of force, or sudden exertion is required)
- iv. Analyses the Upper arm, Lower arm, and wrist.
- v. Determine the coupling score (between 0-3), consider of power grip and hand hold.
- vi. Determine the activity score by considering, three selections; are one or more body parts held for longer than one minute (static), are there repeated range actions (more than 4x/minute); is there action that cause larger range change in posture/ unstable base.
- vii. Lastly, risk index was calculated as well as REBA score for the selected posture.

While assessing the posture and movement of the student during task, interviewing the student were done to gain an understanding of the tasks and demands during the task cycles. The selection of the posture to be assess is considered as the most difficult posture to sustained for the longer period based on the welding process. Another factor of selection needs to be considered is the posture where the highest force loads occur. With REBA only the right or left side is assessed at a time. For this activity both arms should be evaluated since both are holding force loads and at different angle.

4. RESULT AND DISCUSSION

Result from the checklist of questionnaire survey sheet, consist of the body part details for both left-right side of the body with the evaluation time interval of 1 hours (5 students), 1hour 30 minute (10 students), 2 hours (5 students), 2-hour 30 minute (5 students) and 3 hours (5 students) of the task performance. The data is required to analyses the welding posture. Conclude from Figure 2, there's six body part which is eyes, neck, shoulder, upper arm, wrist, and foot that contribute to body pain while participate in welding process. The pain is due to;

- Eyes – eyes strain from the spark and heat, and frequent visual inspection of welding quality
- Neck – rotates frequently to observe welding quality and placement of arc on the metal
- Shoulder – retain same position one side hand holding welding equipment, another hand holding shield face.
- Upper arm- retain and focusing on joining metal, frequent move to remove slags.
- Wrist – the equipment and face shield load force, retain for a specified time.

- Foot – static standing on hard floor with slide bending knee for a specific time (imbalance). The position of foot frequent change to adjust a good view of the welding table while joining the metals.

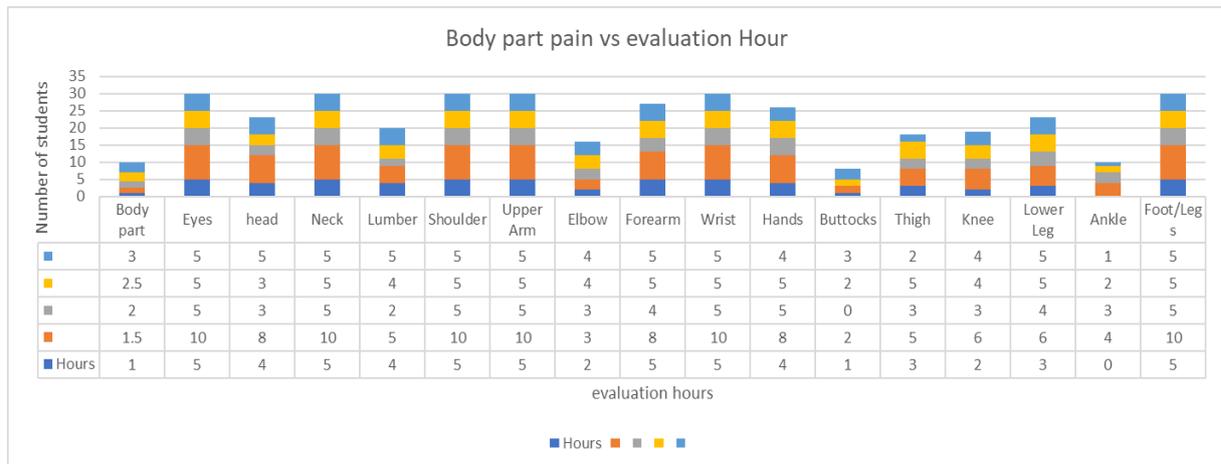


Figure 2: Checklist result of body pain and evaluation hours

Table 3.0, explain the most frequent posture used by student to weld. An awkward posture attempt to seek the comfortless while welding. REBA used to identify the severity of the posture while doing the task, it examines the risk factors and rates the severity of awkwardness that range from 1-12. After all entries are selected, an overall REBA score will be determined. This score represents minimum score of 1, and the maximum score of 15. REBA assessment goal for design is a score of 4. The risk represent how significant is the risk to develop MSDs for the task. Risk that denotes greater than 1.0, means the task is high risk for some selection of the group (welding selection evaluation hours). Another factor to be concern that reflect to the result of medium risk that untrained student takes more time to complete the task and are serious concern for having more pain on the body parts. Muscle pain are significantly connected due to all the body part present, the student rate as having pain after welding process, where it needs versatile and high precision and focus. Evaluation hours

REBA score risk for the selected position ≥ 4 , which is medium risk and an action need to be further investigated either to change the workstation workbench from standing to sitting, or the find an aid for example arm support due to long hours of welding process. To design a platform for workbench standing, there's need a study on the actual posture of the student while welding. The parameter and dimension of layout workstation need to be measured

Table 3: Selected Posture and activity explanation

Posture	Position	Explanation
	Back Position	Bend 20-60°
	Hand	Both hands below the shoulder position Movement 45-70°
	Feet	Both legs rest completely on the floor Knee 10-30°
	Force Load	<5kg
Welding is performed in awkward posture and condition. Practical time take to 1-3 hours.		

5. CONCLUSION AND RECOMMENDATION

It has been observed that, welding posture and position are serious concern and incaution of ergonomic at workshop that result in muscle pain. During the welding process, high precision and focus are required from student to join the metal. Higher REBA score 4-11+ required change and further investigation. Several welding posture can be grouping into four categories, which is students' posture while operating a welding control panel, students' posture while tack(joining) the metals, the students' posture while setting the task for welding and the students' posture while adjusting welding arc. The REBA evaluation score for each category is ≥ 4 and required further investigation. Majority of the student are new to the welding process; this contributes to lack of skilled and the handling of equipment (geometry) affects their wrist and poor consistency of tacking the metal together. The long hours of exposure to the welding process and heat result in fatigue. By considering data from checklist survey, the student should be given appropriate training hours for better posture while operating welding machine.

Recommendation.

1. While for institution, for workshop learning activity, the exposure of workstation design and layout as well as constrained environment need to be aware.
2. Ergonomic principle needs to be expose to the students.
3. Relocate the task performing area to minimize the movement and more to neutral posture.
4. Exercise needs to be performed and implement before workshop activity happen, to increase in muscle mass and strength as well as cardiovascular endurance.)

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