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CMDQ, A TOOL FOR PAIN SENSATION SOLUTION FOR ERGONOMIC POSTURAL ASSESSMENT DURING PRACTICAL LABORATORY WORK

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Graphical abstract

Abstract

Human activity in the technical education sector, particularly practical activities such as workshop work, is stressful and tiring, with existence of risk and hazard. Previous studies have been conducted to assess postural risk factor using score decision during their practical work in workshop. Hence, this study adopts a Cornell Musculoskeletal Discomfort Questionnaires (CMDQ) as a solution tool aims for students involve in practical activity. Respondent (n = 5) are consisting of students attend welding practice throughout the semester. The respondent was given a detailed CMDQ questionnaire for student to measure the level of discomfort while doing their practical task. Frequency of occurrence, discomfort, and working capability, will be combined to create total CMDQ scores. Additional of individual interviews were utilized to quantify pain emotions and explore the frequency of discomfort. The finding shows that respondents are having the pain sensation after their practical work. This indicates that the student version of CMDQ is a feasible tool to assess ergonomic postural risk during practical laboratory work.

Keywords: Student, MSD pain sensation, CMDQ, practical, laboratory

Abstrak

Aktiviti manusia dalam sektor pendidikan teknikal, terutamanya aktiviti praktikal seperti kerja amali, memberi tekanan dan memenatkan, juga terdapat risiko dan bahaya. Kajian terdahulu telah dijalankan untuk menilai faktor risiko postur menggunakan keputusan skor semasa kerja amali mereka di bengkel. Oleh itu, kajian ini menggunakan Soal Selidik Ketidakselesaan Muskuloskeletal Cornell (CMDQ) sebagai alat penyelesaian bagi pelajar yang terlibat dalam aktiviti amali. Responden seramai 5 orang adalah terdiri daripada pelajar yang sedang menjalani sesi amali kimpalan sepanjang semester. Responden telah diberikan soal selidik CMDQ secara terperinci untuk pelajar mengukur tahap ketidakselesaan semasa melakukan kerja mereka. Kekerapan berlaku, ketidakselesaan, dan kebolehan bekerja, akan digabung untuk mendapatkan jumlah skor CMDQ. Tambahan temubual individu digunakan untuk mengukur emosi kesakitan dan meneroka kekerapan ketidakselesaan. Dapatan kajian menunjukkan bahawa responden mengalami rasa sakit selepas melakukan kerja email. Ini menunjukkan bahawa CMDQ versi pelajar adalah alat yang boleh dilaksanakan untuk menilai risiko postur ergonomik semasa kerja makmal praktikal.

Kata kunci: Pelajar, rasa sakit rangka tubuh, CMDQ, amali, bengkel

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1.0 INTRODUCTION

Nowadays, a technical student's aptitude is a critical aspect in determining their employment. Improper welder posture, inconducive environment conditions, and inadequate workstation design are some of the most typical issues seen during practical sessions, particularly in welding. Many technical colleges place a greater emphasis on the final product of a practical session than on the process. As a result, the practical session will receive a lesser mark and unavoidable injury will occur during the practical session.

The Engineering Technology Accreditation Council (ETAC) has granted accreditation to a Malaysian technical education institution. One of the ETAC's mandatory requirements for diploma engineering is a minimum requirement for practical tasks of 30 Student Learning Time (SLT), which is equal to 1,200 hours during study [1]. Welding is one of the practical tasks for diploma mechanical engineering students.

For engineering students, practical work is one of the required learning processes, and it is mandatory to graduate. Students in Malaysian Polytechnic's, Department of Mechanical Engineering must undertake welding practical work from the first to third semesters, followed by application of welding skills in project courses in the fourth and fifth semesters. A student must execute welding work from the preparation of practical materials until it is given to the instructor for evaluation to ensure that the practical work is carried out according to particular learning objectives.

In general, providing practical work material entails selecting materials that are suitable for welding techniques such as Tungsten Inert Gas (TIG), Metal Inert Gas (MIG) or gas welding, as well as cutting materials, all of which must be completed before the practical work process can begin. Students must maintain a consistent and static body position to ensure that practical work follows the experimental design. The location of the body is determined by the practical work process, which begins with the preparation of practical work materials and ends with the completion of welding operations. Welding employment involves welding postures, which have a direct impact on the student's body posture.

The underhand, vertical, horizontal, and upper head positions are the most popular welding positions for students. Depending on the welding task, any of these welding positions will allow the body's posture to be static for a period of time.

During the welding process, the most common ergonomic risk factor was a prolonged static body posture position, as well as uncomfortable body posture and fume exposure [2]. These occupational risk factors can result in musculoskeletal disorder (MSD) from welding activity. MSD is a muscle, nerve, tendons, ligament, blood, and bone tract injury and illness [3]. As a result, students may get exhausted, fatigued, or injured. If the student is not in good physical condition to complete the work, the quality of the weld may compromised. When there are problems in the welding work, such as porosity, excessive spatter, inadequate connection, lack of penetration rate, excessive penetration, burns, and bend, the welding quality is severe [4].

The tense condition of the body can happened during prolonged static posture. This might put an excessive amount of strain on the body, resulting in the accumulation of bodily fluid at the foot [5]. Furthermore, extended sitting period might injure the back body [6]. Someone who is in the same position or posture for an extended length of time is said to be in a static position. This condition will create muscular tension or exhaustion to maintain a static posture during the work, which is one of the factor in the body frame's danger. The amount of damage risk is affected by the duration of the static condition, difficult position, and energy levels employed. Static positions are also known as static loads [7].

Static postures can result in a lack of blood flow to the muscles, preventing the body from participating in its natural healing and repair processes. Fatigue, inflammation, and nerve injury can all contribute to the breakdown of body frames due to static positions. As a result of the continuous exposure to hazard, this injury is sometimes referred to as a cumulative trauma disorder (CTD) [8]. While holding the instrument in the same position for an extended amount of time, a static position might cause a wrist or hand injury. When executing the welding method, students may have back pain due to static posture produced by sitting in the same location for long periods of time [9].

When doing practical tasks, awkward postures refer to the body's position that is different from its normal position. When the body is in an uncomfortable posture, it is not in the best position for the body. As a result, muscles demand more energy to complete the activity, and they will also work in inefficient and susceptible ways. Twisted, bending, attaining, pulling, or lifting are examples of uncomfortable bodily postures or awkward postures [10]. Awkward postures include working with the hands above the level of the head, elbows, and shoulders, as well as a neck bend of more than 300° [11].

When the body remains in uncomfortable posture for an extended length of time, it can create muscular soreness, which can lead to muscle dysfunction and eventually loss of function [12]. When students do welding tasks that require them to keep their hands away from their bodies for an extended amount of time, their bodies become static. This condition leads students' bodies to get exhausted in short time. At the same time, muscles will also need energy supplements to function properly.

Furthermore, while the student's body is in a static state, blood flow slows, lowering the supply of nutrients to the muscles and slowing the elimination of acid and other excretory wastes from tissue. As a result, muscle healing and recovery become slower. Students should always be able to hold the welding torch for a long time without needing to park it on the holder during welding activities. Further, the wrist muscles become motionless and tense, causing fatigue and inflammation of the muscles and tendons. This research provides a preliminary identification of MSD for engineering students during practical work.

MSD is a medical disorder that can impact the proper functioning of other skeletal system tissues such as the nervous system, tendons, muscles, and supporting structures [13]. Skeletal disorders are a phrase that refers to problems with the skeletal system of the body [14]. MSD is also a condition that happens when a person is engaged in a practical activity while also being exposed to an environment that might impair the normal functioning of skeletal system tissues. MSD will not disclose itself in a radical way unless it begins with small injuries and increases over time. Discomfort in the body frame can also be justified if there are symptoms such as stiffness, weakness, loss of hand coordination power, or difficulty moving the limbs, as well as pain, swelling, redness, heat, loss of feeling, cracking, or fractures of bones and joints [15]. This problem has been accumulated for a long time and it raises enormous loads during work, causing discomfort, inflammation, bruising, and finally, acute pain in the limbs.

Each person's capacity to work on body tissues (muscles, tendons, joints, and ligaments) will deteriorate as they get older. Reduced tendon and muscle elasticity causes an increase in cell death, resulting in a reduction in the function and ability of muscles, tendons, and ligaments, as well as an increase in the mechanical stress response, exposing the body to MSD. As a result, the risk of developing MSD increases with age. MSD generally strikes people between the ages of 25 to 65. The initial symptoms usually appear around the age of 35, and the severity of the symptoms increases with age [16].

MSD can cause a reduction in job productivity, as well as a reduction in working hours and the possibility of temporary or permanent incapacity [17]. Questionnaires based on the CMDQ can be used to determine the degree of discomfort to gain an overall picture of MSD sensation especially for practical students [18].

The level of MSD among the student was assessed using the Cornell Musculoskeletal Discomfort Questionnaire (CMDQ). The CMDQ is a tool for assessing MSD that is simple to use, quick, efficient, and relevant across the board. The primary goal of this study to look into MSD issue among student done their welding practical task based only on the frequency of discomfort.

2.0 METHODOLOGY

Industry player are concerned about worker safety and decreasing work-related risk behaviors such as welding. As a result, ergonomics plays a critical role in decreasing or preventing work-related injuries. Many studies and surveys have been conducted on ergonomic aspects to reduce tiredness and occupational risk, but the results have been restricted due to lack of information and data obtained from workers.

Welding skill is essential in every metal production sector since it can produce good product. Welding tasks frequently necessitates uncomfortable body postures, and time duration is a major issue that can lead to injury. Back injuries, shoulders discomfort, tendinitis, and decreased muscular strength are all common musculoskeletal issues among welders. Students at technical institutions confront major workplace health and safety issues. Students who undertake practical work throughout the day will suffer some discomfort in their body parts, which will influence quality and productivity for subsequent days.

The study has been carried out at Politeknik Banting Selangor, a conventional polytechnic in the Klang Valley that offers a diploma in mechanical engineering that has been accredited by ETAC in 2020. Awkward postures were seen among students during practical welding work.

The activity of the limbs is thus one of the approaches that may be applied to detect abnormalities of the limbs. Thus, Dr. Alan Hedge from discomfort questionnaire, known as the CMDQ, which is one of the most significant muscle assessment tools in the field of MSD [19]. In addition, the CMDQ evaluates MSD that affect one's capacity to work. The parts of the CMDQ questionnaire are split into gender and the consequences of the job activity performed, such as the impact of standing work, sitting work, and wrist impact [20].

For evaluating work activities, postural analysis can be an effective and valuable aspect. The risk of musculoskeletal injury linked with recorded postures in the context of a thorough ergonomic workplace evaluation which can be a key element in implementing change. Therefore, ergonomic practitioners benefit greatly from the availability of task-sensitive field methodologies.

CMDQ was invented from a researcher in Cornell University. This questionnaire is based on studies of MSD among office employees. The usage of this questionnaire is using scoring and very simple to adopted by anybody.

Hedge (1999) employed a questionnaire linked with the Nordic Body Map in study of MSD among keyboard users, including questions on the prevalence of musculoskeletal discomfort, severity, and if the disorder interferes with work performance. Hedge (1999) also found that the CMDQ has the same validity as the Nordic Musculoskeletal Questionnaire based on this review (0 – 20%). As a result, CMDQ can be alternative tool for ergonomic evaluation instrument to measure MSD sensations and can be used for a variety of purposes other than employment [20].

CMDQ are used to identify and record discomfort across the body. There are two elements to a questionnaire body: pain in the body and the Cornell hand, which is intended to be a common part of the body and dedicated to the hand [21]. The complete body inquiry is divided into male and female genders, as well as standing and seated jobs. The left and right halves of the questionnaire form are separated.

Starting with the Turkish version of CMDQ, the German version of CMDQ, and the Malaysian version of CMDQ, CMDQ has gone through numerous phases and evolutions. However, a specific CMDQ student version was employed for this investigation. There is a distinction between each version based on the language utilized in the assessment item in the Turkish, German, and Malaysian versions. However, by deleting the footprint element and replacing it with the finger element, that make a different assessment part in the student version.

The student version of the CMDQ questionnaires was used to screen and identify student at risk of MSD in this study (Figure 1). There are four methods for calculating the overall score on the CMDQ [20] as listed below:

1. Count the number of MSD sensations per person.
2. Sum the rating value for each person.
3. Determine the weight rating to identify the most serious problem as below:

    0 = never experienced,
    1.5 weights = 1-2 times/week
    3.5 weights = 3-4 times/week
    5.0 weights = every day
    10 weights = several times/day

4. Sums up the product of the CMDQ element by the weighting value as

a. Frequency of occurrence

0 = Never
1.5 = 1-2 times/week
3.5 = 3-4 times/week
5.0 = 1 time/day
10 = Several times/day

b. Discomfort

1 = A little uncomfortable
2 = Somewhat uncomfortable
3 = Very uncomfortable

c. Ability to work

1 = Directly uninterrupted
2 = Slightly distracted
3 = Very disturbing

The three types of data collected, namely frequency of occurrence, discomfort, and working capability, will be combined to create total CMDQ scores. The highest CMDQ scores implies that the area of the body experiences pains the most frequently or is more commonly known as a in individual who experiences more painful feeling.

For this study, students with MSD risk were screened and identified using a whole-body questionnaire with stand-alone poses. The third method has been applied in this study according to ergonomic risk assessment guidelines at the workplace (2017) by the Department of Occupational Safety and Health (DOSH) by looking at frequency and ballast, with the goal of assessing pain feelings as well as performing ergonomic risk assessment screening [22]. This method is used because it is simple and concise also only focuses on analyzing ergonomic risk assessment data only. It also chosen because of the period detection of discomfort within a week after performing the practical activity. Compared to some other techniques that need for recorded discomfort sessions spaced out across a month or year.

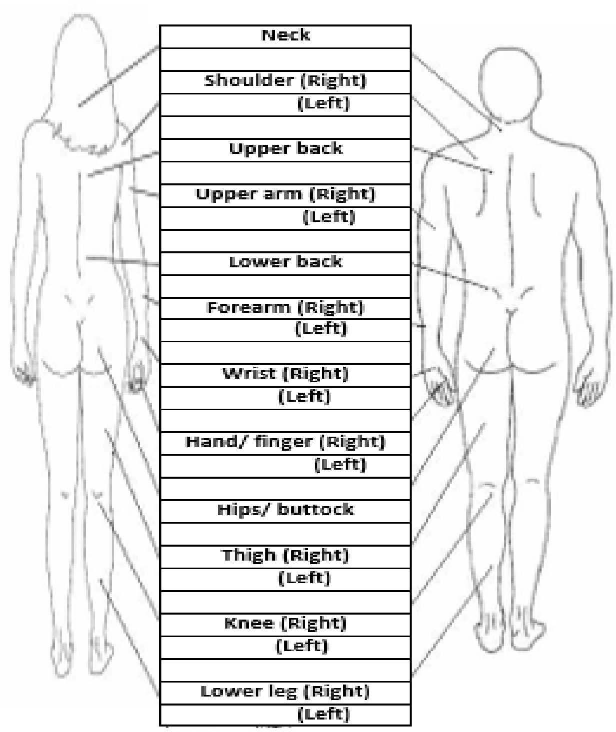

Figure 1 Student version of CMDQ

This research was done at Polytechnic Banting Selangor's for third semester students in Diploma in Mechanical Engineering. This study aims to identify ergonomic sensation that students faced during welding practical work activities. Data was obtained by conducting structured interviews with all participants using the CMDQ questionnaire method. Following the researcher's step-by-step instructions, a total of 5 students consist of 3 male and 2 female who are actively participating in welding practical work were chosen at random and asked to complete the interview CMDQ instrument. the frequency discomfort can be given predefined discomfort scores. Total discomfort score was calculated by using the Equation (1):

$$\text{Discomfort score} = \text{Discomfort frequency} \quad (1)$$

The sample size for this study is 25% of the total number of students in the class who take welding practical subjects. Respondents were doing arc welding for their assignment during the data collection so the welding position is the same but the sensation of discomfort will depend on the students.

There are two parts to this study. However, there is a mandatory part which is to inform the participants about the goals, procedures, direction of the study as well as obtaining the consent of the respondents. The first section of the research asked general questions on gender, age, weight, dominant of hand and years of study. The time allotted for each question's response was given to the subjects. While administering the questionnaire, the researcher answered any questions that came up, but no content-related recommendations. Before or during the study, the subjects were not allowed to speak with or consult with any other respondents. This was accomplished by having each respondent complete their questionnaire simultaneously in a different table.

While the second part is related to CMDQ assessment, to make sure that participants understood what was required, the researchers first carried out a demonstration of the technique. The procedure involved the CMDQ. The participant received a brief introduction before being offered the option to independently complete the CMDQ. Each participant's feedback on the question's clarity and understandability was intertwined.

This study is an exploratory study for CMDQ instrument to explore risk of MSD for engineering students during the welding process. Besides that, the Ergonomic Risk Assessment (ERA) instruments which only focused on the upper body area, the CMDQ approach was chosen for this study because it complies with DOSH guidelines (2017). Aside from that, the CMDQ provides a simple and succinct early screening evaluation prior to executing an MSD risk examination. Thus, the study will recommend certain ergonomic risk control measures for the students, so that the welding practical does not have a negative impact on their health or cause long-term occupational illness.

3.0 RESULTS AND DISCUSSION

The findings of this study can be summarized through Table 1 below

Table 1 Respondents demographic data

No	Item	Average value
1	Age	19 years old
2	Weight	65 kg
3	Height	163 cm
4	Time to complete 1 length of welding line	80 s
5	The height of the work table	80 cm
6	Dominant hand	right

According to Table 1; student is in good condition of healthy. The body mass index (BMI) according to ratio of height and weight still in ideal BMI. Time to accomplish the task is around 80 s for each task. the duration of this work is risky and can cause an awkward posture for a long period of time

Then, the specific findings of the CMDQ from respondents are summarized in Figure 2. The data revealed that there was no risk associated with the respondent's upper back body. That implies no student will experience any discomfort or pain in the affected area. The shoulder, neck, and lower back are three regions that are influenced by practical welding tasks. All the respondents have the same issues, however only three students had issues with their left and right thighs; left and right knees; left and right lower leg.

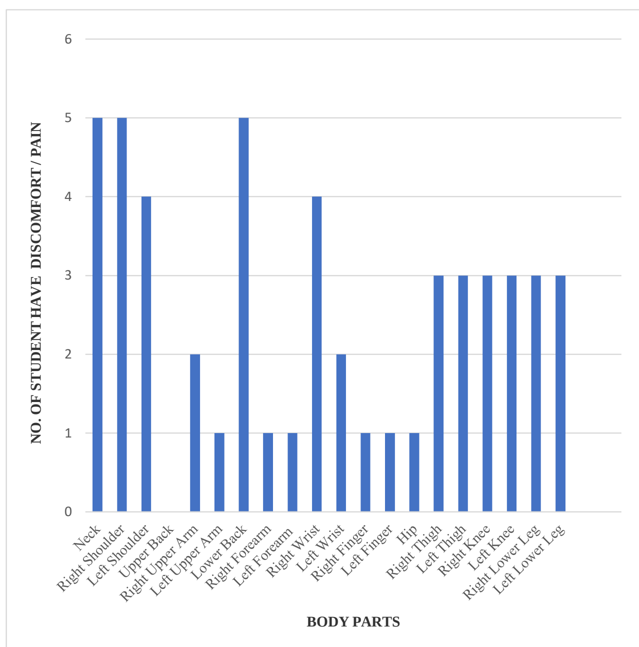

Figure 2 Analyses of CMDQ for five respondents

Meanwhile, two students have been identified as having difficulties with their right upper arms and left wrist. Only one student does not have shoulder difficulties, and only one student has problems with the left upper arms, left and right forearms also right and left finger and hip.

Before handling practical work, students should receive ergonomic awareness training and education. A briefing session with students can be held early in the semester to provide exposure about MSD and other ergonomic issues, followed by physical training and demonstration programmes before entering the workshop to begin practical training. It only takes 5 minutes of stretching and exercising intervals to improve various movements, flexibility, and durability of ergonomic process. Intermittent work with exercise, for example, can stimulates blood-muscle circulation while stretching joints relaxes them [23].

Furthermore, the findings showed that the position of the body during the welding task is crucial to minimize bending posture. Welding materials is best to be positioned at the same level with the chest of the welder. Personal protective equipment (PPE) can, in fact, offer enough protection or reduce risk factors when used properly. Earplugs for noise risk and anti-vibration gloves are examples of PPE that give protection while eliminating risk factors during welding task.

4.0 CONCLUSION

In summary, this research confirms that compared to pain in other body regions, discomfort in the neck, right shoulder, and lower back has been found to be more common. The CMDQ findings for 5 respondents revealed that after executing welding practical work, all respondents experienced pain on the specific area of the body. It is necessary to improve the body's postural position during welding process. This study found that the CMDQ is a compatible tool for ergonomic risk assessment for welding activities in school or educational facilities. Then According to the findings, student version of CMDQ is an alternative tool for identifying ergonomic risk factors for students during welding practical activity and is suitable for early assessment of MSD risk for a whole body. Thus, wider subject of respondents is needed in further study to get a high degree of dependability that can be validated. It is necessary to conduct more research on the connection between musculoskeletal discomfort and productivity. Therefore, the findings of this investigation can be used to further evaluate the effects of MSD.

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