WORKPLACE ERGONOMICS RISK ASSESSMENT IN THE MINING INDUSTRY

NORHIDAYAH MAT SOUT*
MUHAMAD ARIFPIN MANSOR **
AHMAD RASDAN ISMAIL ***

Abstrak

Ergonomik dan faktor persekitaran telah menjadi isu utama bagi industri perlombongan selama bertahun-tahun, dan semakin meningkat. Dalam memastikan persekitaran kerja ergonomik, ianya memerlukan perhatian khusus terutama dalam sektor industri ini. Disebabkan kekurangan pengetahuan ergonomik dan kesedaran yang rendah di kalangan jurutera dalam industri perlombongan, maka ini menjadi isu utama di Malaysia. Tujuan kajian ini adalah untuk menyiasat faktor risiko fizikal yang berkaitan dengan kerja-kerja gangguan muskuloskeletal (WMSDs) dengan menggunakan Penilaian Ergonomik Tempat Kerja (WERA) di kalangan pekerja industri perlombongan. Daripada penyiasatan itu, tahap tindakan daripada WERA adalah medium yang menyatakan bahawa tugas-tugas perlu disiasat dengan lebih mendalam lagi dan memerlukan perubahan. Semua faktor-faktor risiko fizikal melibatkan lima kawasan badan atasan seperti bahu, pergelangan tangan, belakang, leher dan kaki yang telah dikenal pasti berkaitan dengan WMSDs oleh penyelidik terdahulu. Terdapat lapan belas pekerja yang telah dipilih untuk terlibat dalam kajian penyiasatan ini. Pekerja dipilih mengikut tugas pekerjaan mereka. Keputusan analisis yang diperolehi akan digunakan untuk meningkatkan proses kerja, rekabentuk stesen kerja dan juga memperbaiki postur kerja untuk meningkatkan tahap keselesaan pengendali. Kajian ini adalah penting bagi industri perlombongan yang kekurangan maklumat dan penyelidikan mengenai isu-isu ergonomik dalam industri. Dapatan secara keseluruhan menunjukkan bahawa keseluruhan proses tugas pekerjaan terpilih akan menyumbang kepada gangguan muskuloskeletal sama ada pendedahan jangka masa yang singkat atau panjang.

Kata Kunci: Ergonomik, Faktor risiko, Perlombongan

* Pelajar Pascasiswazah di Fakulti Teknologi Kejuteraan, Universiti Malaysia Pahang
** Pensyarah Kanan di Fakulti Teknologi Kejuteraan, Universiti Malaysia Pahang
*** Prof. Madya di Fakulti Teknologi Kreatif & Warisan, Universiti Malaysia Kelantan

Abstract

The ergonomics and environment factors have been the main issue for the mining industry for many years, and their profiles are increasing. To ensure an ergonomics work environment, it is possible to require a particular attention especially in this industry sector. Due to lack of ergonomics knowledge and low awareness among engineers in the mining industry, this may lead to become the central issue in Malaysia. The aim of this study is to investigate the physical risk factor associated with work-related musculoskeletal disorder (WMSDs) by using workplace ergonomics assessment (WERA) among workers in the mining industry. Based on the investigation, the action level of the WERA is medium that stated that the tasks need to be investigated further and it requires changes. All physical risk factors involved the five top body regions such as shoulder, wrist, back, neck and leg. These have been identified to have an association WMSDs by previous researchers. There were eighteen subjects selected in this investigation study. Those subjects were chosen according to their job tasks. The results of the analysis were used to improve the process of work, design of the workstation and also improving the work posture to enhance the comfort level of operators. This study is crucial for the mining industry because there is a lack of information and research about the ergonomics issues in the industry. The overall finding indicated that the whole process of selected job tasks will contribute to musculoskeletal disorder either for a short or long time exposure.

Keywords: *ergonomics, risk factor, mining*

* Pelajar Pascasiswazah di Fakulti Teknologi Kejuteraan, Universiti Malaysia Pahang
** Pensyarah Kanan di Fakulti Teknologi Kejuteraan, Universiti Malaysia Pahang
*** Prof. Madya di Fakulti Teknologi Kreatif & Warisan, Universiti Malaysia Kelantan

1.0 Introduction

In recent years, there has been an increasing interest in quality, health and safety requirement in several occupations. Recently, researches have shown an increased interest in occupational safety and health issue for mining industry in Malaysia. It is becoming gradually more difficult to ignore the issue related to occupational workplace ergonomics risk assessment due the recent studies and statistics. According to statistic report by the Department of Occupational Safety and Health, Malaysia (DOSH) about occupational accidents for the category of death until June 2014, 3 of victims were reported, 17 of victims were reported for Non-Permanent Disability (NPD) and 3 of victims were reported for Permanent Disability by mining industries (DOSH, 2010) . Meanwhile, according to statistics report about the numbers of accidents by industry-year 2012 conducted by Social Security Organisation (SOCSO), 9 cases were reported for fatal accident and 417 cases were reported for disability in mines and quarry industry (DOSH, 2010).

Musculoskeletal disorder is a regular disorder characterized by ergonomics. 448 cases were reported in occupational musculoskeletal disorders by, SOCSO (DOSH, 2010) . The increasing cases reported can be the major issues for the workers are at high risk of developing work-related musculoskeletal disorder (WMSDs) that are associated with exposure factors in this work environment. Despite the high prevalence of work-related musculoskeletal disorder (WMSDs) in mining industry, therefore the aims for this study were to investigate the physical risk factor among the workers in selected job task by using a new development of the ergonomics risk assessment tool which is called Workplace Ergonomics Risk Assessment (WERA) and was developed by Mohd Nasrull et. al (2011) (SOCSO, 2007).

2.0 Methodology

2.1 Subjects and Selected Job Task

Selected mining companies in Pahang and Kelantan states were randomly selected as a field of study in this research. Based on these three workplace of the mining industry out of 18 workers in the selected job were randomly selected as subjects. The selected job task was wet screening to screen the raw material by using manual handling hose.

From the selected subjects, 18 workers were performed in wet screening. The work task was based on the main procedure of selecting the best raw material before the next process. Those workers handle the hose manually to screening all the raw material from 8.00 am in the morning until 5.00 pm with 30 to 45 minutes break at 1.00 pm at afternoon. The hoses weight were more than 20kg under strong pressure, and their body was excessively exposed to repetitive motion throughout the working hours. All subjects were exposed to stand position while handling the hose manually. These investigation was executed for three times, in the morning, at noon and in the afternoon session.

2.2 WERA Method

WERA was developed to provide a method of screening the working task quickly for exposure to the physical risk factors associated with work-related musculoskeletal disorder (WMSDs) (Rahman, M.N.A., M.R.A. Rani, and M.J. Rohani, 2011). A recent study by Mohd Nasrull et. al (2011)(Rahman, M.N.A., M.R.A. Rani, and M.J. Rohani, 2011) used WERA to study the physical risk factors among the workers in the construction industry. The WERA assessment consists of six physical risk factors including posture, repetition, forceful, vibration, contact stress and task duration and its involve the five main body regions which were shoulder, wrist, back, neck and leg. It has a scoring system and actions level that provide a guide to the level of risk and need for action to conduct more detailed assessment. The WERA assessment used a pen and paper technique that can be used without any special equipment and it can be done in any space of the workplace without disruption to the workforce. (Rahman, M.N.A., M.R.A. Rani, and M.J. Rohani, 2011).

The observations of the selected job task were carried out by using WERA assessment. The task was observed in order to collect the data for the WERA assessment, including frequency and repetitive of the activities such as reaching, standing, bending and twisting. From the observation of the WERA assessment, the angle of the some body part segment relative to the vertical was estimated which were the back, shoulder, elbow, and head. The most frequent repetitive posture of task adopted by the workers was taken into consideration for WERA assessment.

3.0 Result and Discussion

3.1 Description of the subjects

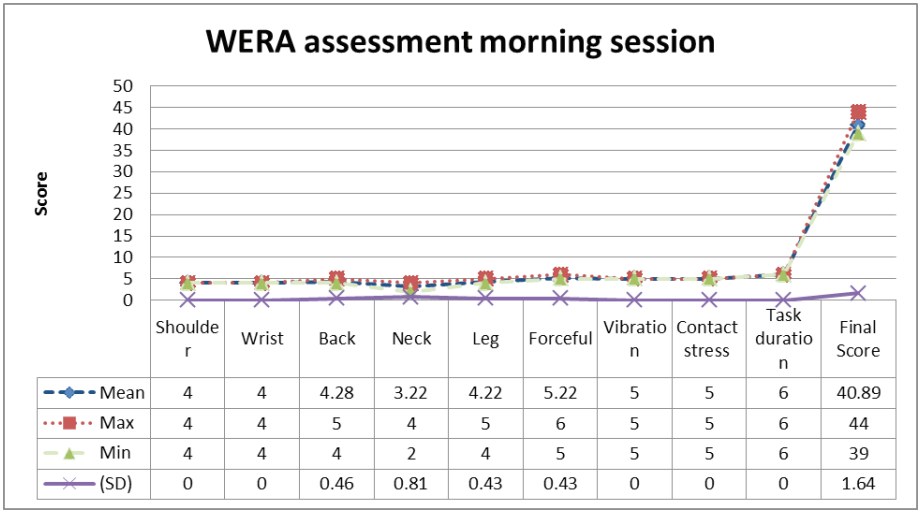
From the wet screening job, out of 18 workers have the age range from 19 to 36 years (mean 2.44±0.86). The working experience ranges from less than a year to 5 years (mean 1.89±0.47). Table 1 shows the demographics of the workers in wet screening.

Table 1: Demographics of the workers in wet screening job

Job	Age (year)			Working experience (year)		
	Mean	SD	Range	Mean	SD	Range
Wet Screening	2.44	0.86	19-36	1.89	0.47	< 1-5

3.2 WERA Assessment

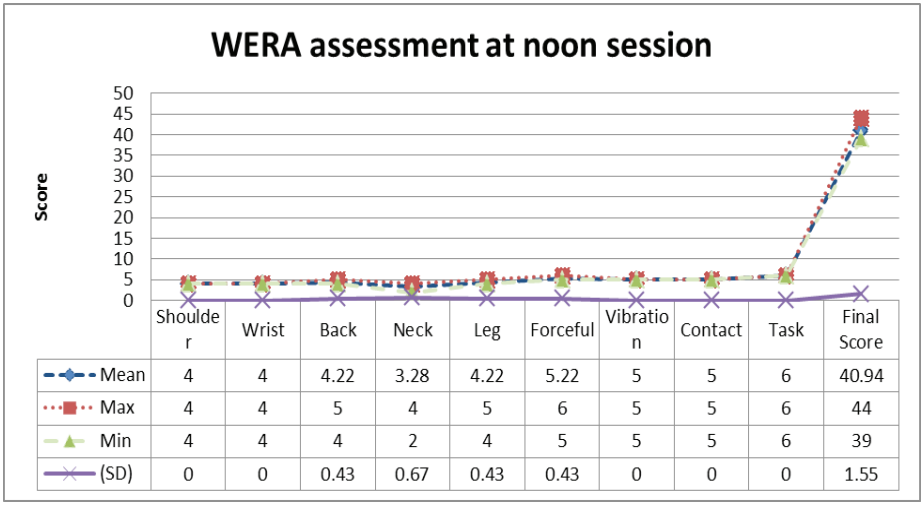
From Figure 1 the morning assessment shows the mean score for the shoulder is 4.0±0.0, as the highest score is 4 where the job tasks are the hands at about the chest level and the shoulder is moderate bent up with the movement with some pauses. The mean score for wrist is 4.0±0.0, and also the highest score for wrist is 4 as the wrist is moderate bent up or bent down with 11 -20 times per minute. The back mean score is 4.28±0.46 as the highest score is 5 with the back posture is moderate bent forward for about 9 to 12 times per minute. The mean score for neck is 4.0±0.81 and the highest score is 4 in which the neck was moderate bent forward with moderate movement with some pauses. Leg mean score is 4.22±0.43 in which the legs conditions are moderate bent forward, or the operator is sitting with feet are bent on the floor. Forceful mean score is 5.22±0.43 where lifting the load is more than 10kg. The mean score for vibration is 5.0±0.0 where the operator is exposed to the equipment that contributes to vibration. Contact stress mean score is 5.0±0.0, and the operators are not using hand glove when handle the equipment. The score for the task duration is 6.0±0.0 as the workers work more than 4 hours per day with the highest forceful handling equipments. The final score of WERA assessment for morning session is 40.89±1.64. The action level for this assessment medium is the task which is needs to further investigation and required changes as Mohd Nasrull et. Al (2011) stated by his previous research.



	Shoulder	Wrist	Back	Neck	Leg	Forceful	Vibration	Contact stress	Task duration	Final Score
Mean	4	4	4.28	3.22	4.22	5.22	5	5	6	40.89
Max	4	4	5	4	5	6	5	5	6	44
Min	4	4	4	2	4	5	5	5	6	39
(SD)	0	0	0.46	0.81	0.43	0.43	0	0	0	1.64

Figure 1: WERA Assessment at morning session

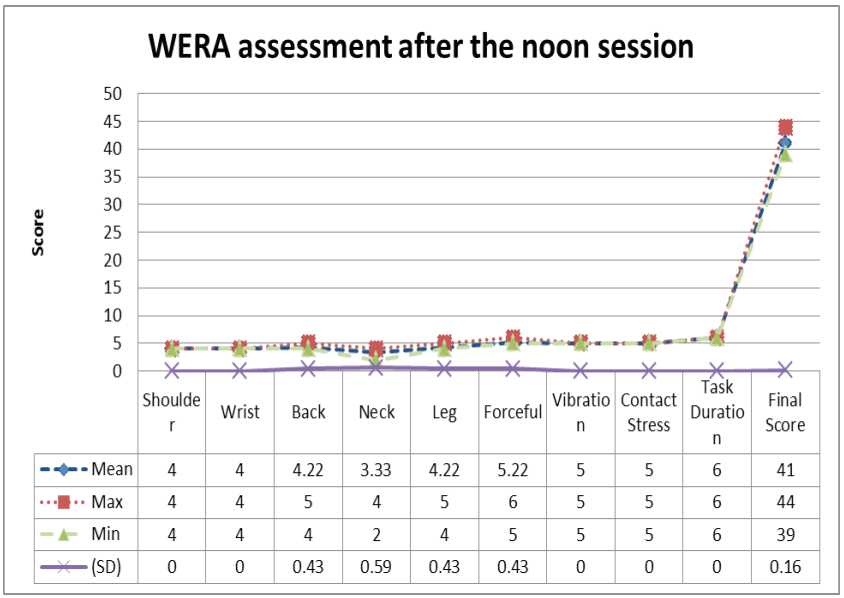
It is apparent form of figure 2 that very few of the score show differently from the morning assessment. The noon assessment shows that shoulder mean score is 4.0±0.0 and the highest score is 4 where the tasks are the hands are at about the chest level with the shoulder is moderate bent up and movement with some pauses. Wrists mean score shows that 4.0±0.0 and the highest score is 4 as the wrist are moderate bent up or bent down for about 11 to 20 times per minute. In back mean score was 4.22±0.43 with the highest score 5 in which the back is moderate bent forward with 4 to 8 times per minute for the repetition. The neck score was 3.28±0.67 and have the highest score 4 as the neck is moderate bent forward and moderate movement with more pauses. Leg mean score was 4.22±0.43 where the highest score was 5 in which the legs are moderate bent forward or the operator sitting with feet are bent on the floor. The score for forceful was 5.22±0.43 as the highest score was 6 as the lifting the load more than 10kg. The vibration score was 5.0 as the operators were constantly used of vibration equipment with more than 4 hours per day as the highest score throughout the whole noon assessment. The mean score for contact stress was 5.0±0.0 and shows all the operators carry out almost the same way of working in handling the contact stress and never used hand glove as their hand protection. As the exposure of task duration among the operators were more than 4 hours per day as the mean score was 6.0±0.0. The final score was 40.94±1.55 in the range of medium score with the action level that was stated by Mohd Nasrull et. All (2011) to further investigate and required change for the whole task.



	Shoulder	Wrist	Back	Neck	Leg	Forceful	Vibration	Contact	Task	Final Score
Mean	4	4	4.22	3.28	4.22	5.22	5	5	6	40.94
Max	4	4	5	4	5	6	5	5	6	44
Min	4	4	4	2	4	5	5	5	6	39
(SD)	0	0	0.43	0.67	0.43	0.43	0	0	0	1.55

Figure 2: WERA Assessments at Noon Session

Figure 3 above revealed the result of after the noon session assessment. The shoulders mean score was 4.0±0.0 same as the noon and afternoon session assessment in which the operators carry out almost the same posture for the whole working day. Wrists mean score was 4.0±0.0 also had the same score during morning and noon session assessment. It is shown that the operators also carry out the same type of handling of the equipment for the whole day. The back mean score was 4.22±0.43 as the highest score was 5. The operators back become extreme bent forward as the operator getting tired from the handling the heavy equipment. Neck means score was 3.33±0.59 as the score getting higher than morning and noon session assessment. The assessment showed the neck operators getting bent forward from 10º to 20º with light movement and more pauses. The leg score was 4.22±0.43 as the highest score was 5. There were few operators handling the equipment with legs are extreme bent forward, and there was a few of operators that were sitting with the feet do not touch the floor. Forceful mean score for after the noon was 5.22±0.43 as the highest score was 6. As the same load more than 10kg were used for the whole day. Vibration mean score was 5.0±0.0 same as with morning and noon session as the operators were exposed with the same equipment for the whole working day. Contact stress means score was 5.0±0.0 same as the morning and noon score. The operators' constant used of vibration equipment for more than 4 hours per day. All the workers were exposed to task duration for more than 4 hours per day as the mean score stated the highest at 6.0±0.0 and the final score for after noon assessment session was 41.0±0.16 as stated in Figure 3. The action level was medium as Mohd Nasrull et. al (2011) previous study mention the task need to further investigation and required change.



	Shoulder	Wrist	Back	Neck	Leg	Forceful	Vibration	Contact Stress	Task Duration	Final Score
Mean	4	4	4.22	3.33	4.22	5.22	5	5	6	41
Max	4	4	5	4	5	6	5	5	6	44
Min	4	4	4	2	4	5	5	5	6	39
(SD)	0	0	0.43	0.59	0.43	0.43	0	0	0	0.16

Figure 3: WERA Assessment after the Noon Session

3.2 Discussion

Based on the result analysis, the result shows all the three times of the assessment were determined as medium with the range 39 to 44. These result shows that the job task is needed to further investigate and required change. The five main body regions started with shoulder shows that the score was average by 4 and conclude to be medium risk level. Previous study by Anthony and Keir (2010) it was found that adding a 0.5 kg load to the hand increased shoulder muscle activity by 4% maximum voluntary excitation (MVE) and an empirical study on the influence of external factors such as arm posture, hand loading and dynamic exertion on shoulder muscle activity and this provided insight into the relationship between internal and external loading of the shoulder joint. The WERA assessment result for the shoulder repetitive motion was determined as moderate as the movement with some pauses. Bernard (1997)[9] has been found that highly repetitive shoulder/arm movement increase the risk of shoulder tendon disorder.

Other than that, Bernard (1997) also reported the awkward wrist/hand posture also is a risk factor for the development of wrist disorder with combination of other factors such as force, repetition and duration. From the WERA assessment, the wrist is moderate bent up or bent down with 11-20 minutes as the score risk level of the wrist also determine as medium. Chen et. al (2006)

studied the interaction between wrist flexors contraction and joint position was significant only in the wrist reflection position while joint position exerted a powerful influence on length-tension regulation in multi articulate wrist flexors, three wrist positions (neutral, flexion and extension) and four level of flexor contraction.

All three WERA assessment determine the back risk level was medium as most of the subjects back is moderate bent forward with 4-8 times per minutes. The back posture categories were defined as 0º-20º, 21º-60º and more than 60º in David et. al (2008) studied which is the same use with the WERA tool. Bernard (1997) has studied that the increasing risk of low back pain was caused by with the increased frequency and repetitive of back movement when carrying out manual handling task. The next body region involves was neck. The risk level score was averagely determined as low by WERA assessment. Most of the necks' subjects were low bent forward with the angle 0º-10º with more pauses during the working hours. As previous study by Keyserling et. al (1993) stated that the awkward working posture at the trunk, neck and shoulder may be caused by a number of factors such as workstation layout, visual demand of the job, design of equipment and tool and work method can be influence the neck disorder.

From the assessment all of the subjects were exposed with prolonged duration from 8.00 am in the morning until 5.00 pm afternoon. The legs in the natural position with the feet are flat on the floor. The WERA tool determines that the risk level for legs was medium as the prolonged duration standing during the working hours was more than 4 hours a day. Further study by Talis et al. (2008) it was stated that when performing maximal voluntary contractions, or during walking and quiet standing, the inter-limb difference in the maximal force production, stance/swing phase durations or weight bearing was typically less than 10% which can be influence the leg disorder.

4.0 Conclusion

The result of this assessment shows that the subjects were exposed to all the physical risk factors such as posture repetition, forceful, vibration, contact stress, and task duration. As a conclusion, we can say that the wet screening task was in level as high as medium. The task needs to immediately change for the health concern to the workers involve. The present study was designed to determine the level of physical risk factor among the workers in mining. Further study need to be done to ensure the cause of the highest contribution of significant risk factors to the WMSDs among the mining workers.

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