A PRELIMINARY STUDY OF POSTURAL SAFETY AND LOW-COST ELECTROMYOGRAPHY (EMG) TOWARDS LOGISTIC WORKERS IN KUCHING SENTRAL

Mohd Azrin Mohd Said[1,2*], Mohd Hasanal Sufri Umar[1], Nor Kamaliana Khamis[2], Aishah Arsad[3]

[1]*Department of Mechanical and Manufacturing Engineering, Faculty of Engineering, Universiti Malaysia Sarawak, Kota Samarahan, Sarawak, Malaysia*

[2]*Department of Mechanical and Manufacturing Engineering, Faculty of Engineering & Built Environment, Universiti Kebangsaan Malaysia, Bangi, Malaysia*

[3]*Institut Tadbiran Awam Negara (INTAN) Kampus Sarawak, Kota Samarahan, Sarawak, Malaysia*

[*]For correspondence; E-mail: msmazrin@unimas.my or mohdazrin.unimas@gmail.com

ABSTRACT: *In lifting the heavy object, the muscles of a person are strained. The incorrect posture of lifting objects may lead to some damage to muscles causing back pain or low back pain. This back pain is mostly reported as musculoskeletal problems in the workplace and as individuals. The back pain of the worker can be reduced if the worker is following the DOSH Lifting Requirement. Therefore, this study is conducted to evaluate the worker's postural safety while lifting and to investigate the factors that affect muscle activity by identifying muscle activation at the back of the body. The data were collected from the selected logistics bus company located in Kuching Sentral Bus Terminal, Sarawak. The developed low-cost electromyography (LCEMG) device was used to identify the raw EMG signal of the workers. The data collected can be visualized by using App or Web-based that displayed real-time data monitoring of EMG signal through ThingSpeak. The comparables of body posture while lifting the heavy object with and without using the belt support among the workers at Kuching Sentral Bus Terminal were also measured and analyzed using Human Builder in CATIA Software to get RULA Analysis score. The result shows that the efficiency of lifting with less back pain was dependent on the belt support that the worker used. It also shows that muscle activity can be reduced if the worker using the belt with the correct posture to lift an object.*

Keywords: Postural safety, Low-cost device, Electromyography (EMG), Workers, Logistic, Low back pain, RULA

1. INTRODUCTION

Physical activity is a factor influencing personal satisfaction and life span. One of the most common physical activities by society is lifting an object. If lifting heavy objects or do repetitive works for a longer time without correct body posture will lead to musculoskeletal disorders (MSDs) problems. Sometimes it is assumed that if this physical activity using smaller and weaker muscles to lift the heavy objects, it might strain the muscle which will cause fatigue and injury. Therefore, strong muscle of the thighs and hips are needed by bending the knees and squatting. Avoid bending from the waist when lifting, as this involves the small muscles of the back. Without correct body posture, it led to the injury of the back muscles.

As the study shows that, low back pain (LBP) is a common health problem where most workers are expected to experience symptoms of low back pain during their working in the workplace [1,2]. Many studies show that low back pain (LBP) of the workers gives a significant impact both directly and indirectly to themselves and also their families, industries, and governments [3,4,5,6]. On the other hand, research also states that LBP is the fourth-most common reason for hospitalization for the worker due to work-related musculoskeletal disorders (MSDs) [7]. Therefore, a study on this musculoskeletal disorder can help the worker to reduce the LBP to prolong the lifestyle and working life in the workplace.

To investigate the muscle activity towards workers back muscles, the integrated usage of electromyography (EMG) is one of the methods. As is know that EMG signals are considered most useful as electrophysiological signals in both medical and engineering fields [8]. EMG signals can record the basic human body's behaviors under normal and pathological conditions [8]. To date, there has been limited study on EMG toward logistic workers, especially in Malaysia. A general study indicates some workers tend to not wear belt support as back protection while performing the lifting work. Other than that, workers also sometimes performing lifting works without correct posture and ignore the safety of their back. Therefore, the purpose of this preliminary study is to identify the awareness of back pain problems among workers and investigate the muscle activity of the workers using developed low-cost EMG device.

2. METHODOLOGY

The research strategy of this study is based on the projects or articles that have been conducted by other researchers. The information such as facts regarding back pain injury, the postural safety to loading and unloading heavy objects, the effectiveness of the posture brace, an existing system for loading and unloading luggage at the logistic workplace was gathered from the literature reviews. This questionnaire also used indirectly partly used Nordic Questionnaire for Musculoskeletal Symptoms identification [9]. This study includes the observational method with the survey method, testing byusing developed low-cost EMG devices and analyzing the Rapid Upper Limb Analysis by using CATIA software. CATIA can simulate the manikin to imitate the human movement to get RULA analysis [10].

2.1 Questionnaires

Data were collected via anonymous questionnaires. The questionnaires consist of personal details of the workers at the logistic center and how the logistic activity affected them. All of the 10 respondents (workers) from the 2 different

logistic bus companies were involved in this study due to the constraint of the management factors and workplace. As for this experimental research, the low-cost EMG device also been used to analyze the back-muscle activity.

The selected logistic company in this study was at Kuching Sentral Bus Terminal, Sarawak. A survey of the logistic workers at the selected logistic center was conducted to find out the problem and risk of back pain injury. A questionnaire consists of five sections was used in the survey. The purpose of this survey is to collect primary data on the physical attributes and other information related to heavy lifting during baggage handling for bus transport. The factor that related to comfort the workers while doing their work will be included in the questionnaire. The external factors such as the normal weight of luggage per person and clothing are taken as a constant in the analysis.

The amount of luggage that needs to be loaded into the compartment of the bus will be constant which is 10 and the size of the luggage must be medium (5-15kg) and big size (more than 15kg) only. The time taken for the respondents or workers to complete their tasks will be determined. Respondent or workers that have been completed the whole experimental procedure will be asked to drink water to keep their hydration status adequate.

2.2 Low-Cost EMG Device

The low-cost electromyographic (EMG) were recorded the Raw EMG signal of muscle activity using pairs surface EMG electrodes. The electrodes attached along the lower and upper back muscles to evaluate the activation of muscle after the process of cleaning the skin is done. This developed low-cost EMG device is shown in figure 1. This low-cost EMG (LCEMG) device will transmit the data to the ThingSpeak service platform cloud database and can visualize real-time by using the App or Web-Based.

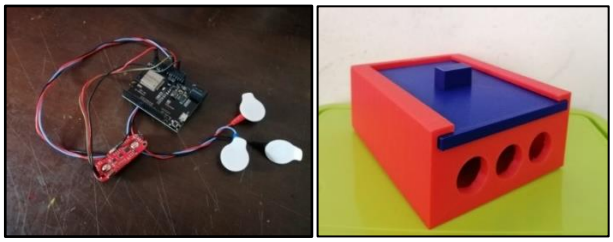

Fig 1: Developed Low-cost EMG Device

2.3 Data Analysis

The developed low-cost EMG (LCEMG) Device designed to be portable for the ease of the experiment. The observational method used to monitor the body posture of the worker's movement while they are doing their work by using the video camera. CATIA V5 is used to determine the Rapid Body Assessment (RULA) score. The worker was a model using Human Builders in CATIA software. Each score will assign to wrists, forearms, elbows, shoulders, neck, trunk, back, legs, and knees. The body regions that have been the score will be determined and improve all the affected areas. The higher the score, the more risk may occur to the body. The list for the RULA score [11,12] is shown in table 1 below.

Table 1: The Rapid Upper Limb Assessment (RULA) [11,12]

Score	Level of MSD Risk
1-2	negligible risk, no action required
3-4	low risk, change may be needed
5-6	medium risk, further investigation, change soon
6+	very high risk, implement change now

3. RESULTS AND DISCUSSION

In this study, the results of the questionnaire were discussed to investigate the worker experience of the muscle back pain problem and their perspective about postural safety. The postural analysis using a low-cost EMG device and muscle activity was conducted and discussed to identify the objectives of this study.

3.1 Questionnaire results

There are 10 respondents (workers), from two different logistic bus company were selected. The company using the bus to transport the logistic items to other Sarawak regions such as Sarikie, Sibu, Bintulu, and Miri. This due to the price is lower compare to air transportation or other commercial logistic company such as Poslaju.

From figure 2, it found that most of the worker's age is the range between 20-25 (50%) and 26-30 (40%) years old. This is due to the backbone endurance overage. According to Mr. Sarbini, one of the senior workers, "as the age workers getting older, it is not recommended to continue working in this field as the endurance of the backbone getting weaker." Therefore, most of the senior workers are move to another department that not related to physical work.

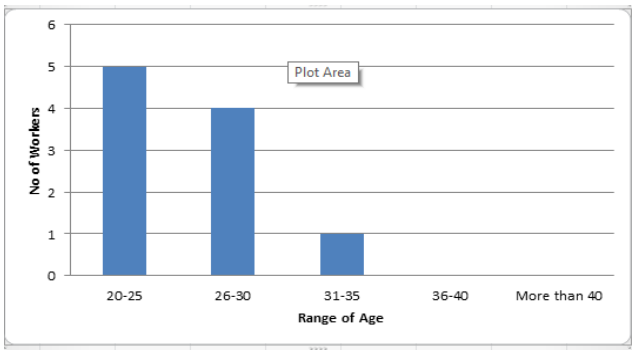

Fig 2: Worker, age range

Lifting the heavy objects with correct body posture can prevent back injury, but it is something that even workers struggle with because as they lifting the heavy object, they tend to lift with their own comfort without considering the correct posture. As for the prior knowledge, all the workers know the correct posture while lifting the heavy object and it is proved by the data shown in figure 4. According to what Mr. Sarbini says, "mostly workers have been told regarding the correct technique in handling the heavy object, but they're still got minor injury towards the workers because they do not follow the correct technique."

From this study, the survey shows all the workers have experienced back pain problems. Figure 3 shows the classification of the injury that has been experienced by the respondent.

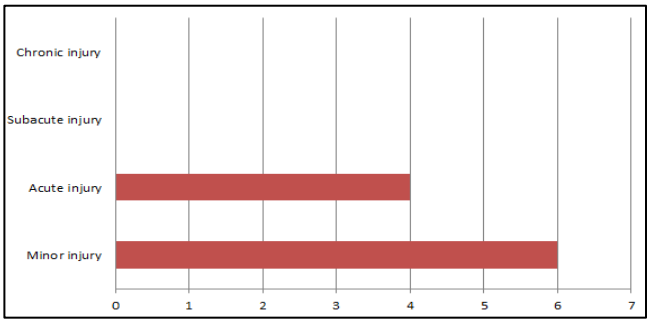

Fig 3: Classification of the injury

Based on figure 3, the data shows that most of the workers having a minor injury 60% and acute injury 40%. This is due to the lack of postural safety while they're doing the work. Other than that, most of them do not warm-up and stretching before and after doing work. This also can be one of the reasons for low back pain injury.

In this study also, we found that most of the workers agree on using the belt back support can reduce the chance of injury. Unluckily none of them are using it while lifting the heavy object. Figure 4 shows the various types of belt back support in the market and workers' preferences. There are about 80% of workers being chosen type D as the most efficient and suitable to use while doing work. However, there are some workers who did not agree with using the belt back support while doing work as it will make their movement limited and discomfort.

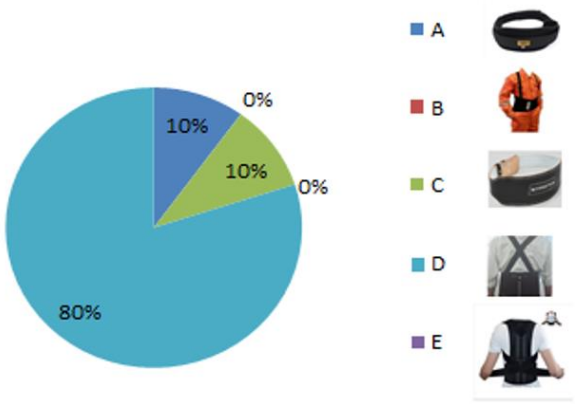

Fig 4: Preferences belt back support

3.2 Low-cost EMG and CATIA

The signal from the LCEMG device was recorded a raw EMG signal for muscle activity in amplitude (mV). The muscle activity was done towards the logistic workers while lifting an object of 15kg. The muscle activity was recorded by LCEMG device and monitor in real-time via the ThingSpeak platform through mobile phone or laptop. The LCEMG device was put inside the casing and attach to the belt back support type D as it is the preferred chosen by the workers is shown in figure 5.

Fig 5: LCEMG position with back support

Fig 6: Comparison results for underweight worker

Figure 6 shows the results of raw EMG Signal between wearing a belt and without belt support for selected under-weight male workers throughout lifting the heavy object. The highest peak of the raw EMG signal when the workers not using belt support is approximately 4000 (mV) compare to the highest peak of raw EMG signal when using the belt support is about 2000 (mV). This indicates that this underweight male worker uses more energy, in other words, its muscle activation is high when not using the belt support.

Fig 7: Comparison results for normal weight worker

Figure 7 shows the results of raw EMG Signal between wearing a belt and without belt support for selected normal-weight workers. The result shows the least muscle activation when using the belt support with raw EMG Signal is about less than 2500 (mV) compared to without belt support that is

more than 2500 (mV) respectively. The graph shows the uptrend when the worker did not use the belt support over time due to its muscles start to fatigue, but the worker keeps on pushing to lift the heavy object. In contrast, the graph shows a downtrend when the worker used the belt support due to its comfortable when using the belt support and reduce the muscles fatigue and activity.

Fig 8: Comparison results for overweight worker

The comparison graph for muscle activation for the selected overweight male worker is shown in figure 8. The graphs represent the muscle activity of the worker lifting the heavy object in 4 minutes. The graph of raw EMG signal for the worker when not using the belt support shows fluctuate and mostly about 2500 (mV) compare to the graph when using the belt support shown to be more stable between the 0-2500 (mv). This shows that the worker can lift more weight and it will break the limit when the weight is more than 30kg. However, belt support shows that it can reduce the muscle activity of workers and this can reduce lower back pain injury.

Fig 9: RULA analysis for underweight worker posture

Figure 9 shows the body posture for under-weight workers and the body posture has been simulated and analyzed using Human Builder in CATIA software for RULA Analysis. From the recorded movement, an initial and second worker posture shows the wrong body posture where his head is looking down and his body is slightly not perpendicular to the ground. This is due to adjust the stability between the body and the weight of the load. The RULA result for this posture in CATIA V5 software shows the RULA Score of 7 which is dangerous, and it must change the posture to the correct one to prevent back pain injury to the worker. This prolonged unsafety posture if not change lead to worker injury in future.

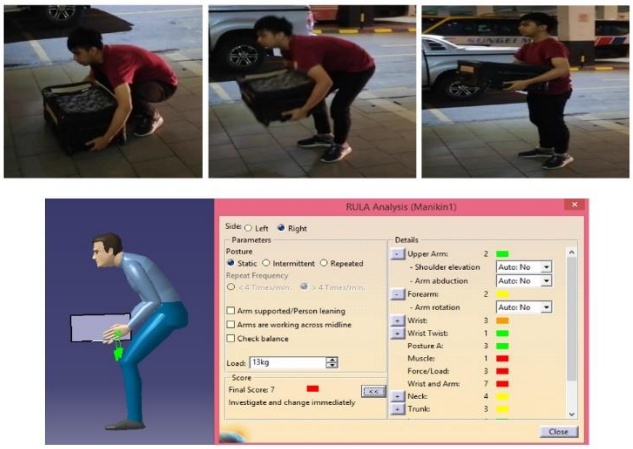

Fig 10: RULA analysis for normal weight worker posture

The body posture for normal weight male workers is shown in figure 10. For the ideal weight male worker, the initial posture was correct, but the second posture is showing the worker slightly bending to the front to deal with the weight of the load. The RULA Analysis also shows the final score of 7 with red color which is dangerous. This body posture will lead to back pain injury if the workers keep doing this activity without correct body posture.

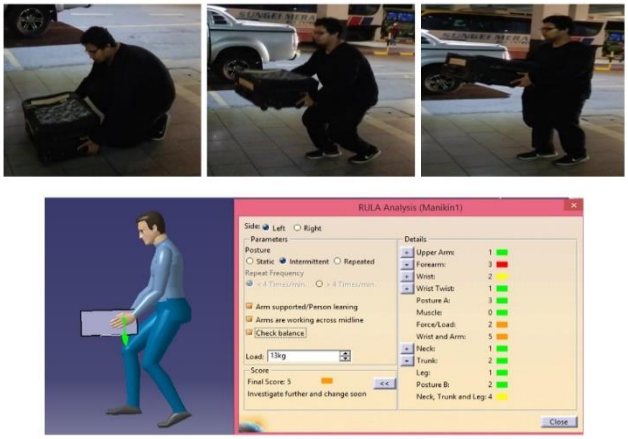

Fig 11: RULA analysis for overweight worker posture

Figure 11 shows the body posture of the overweight worker and the posture. The worker shows the correct body posture while lifting the heavy object. According to DOSH Manual Handling at the workplace, The combination of high load, poor body movement, and frequency of doing the same tasks cause a high internal load on the structure of the human body and increase the risk of injury and pain [13-15]. The correct posture can prevent problems related to musculoskeletal

disorders (MSDs). RULA analysis result shows that the score is 5 and orange color, which needs to investigate further, and action must take soon. The body posture was also observed not following the right body posture due to overweight. This also is one of the factors to lift with right body posture. According to the previous studies by other researchers, there is a direct relationship between LBP and overweight confirming that intervertebral disc degeneration and the development of LBP [16, 17].

4. CONCLUSIONS

This study shows the importance of following the correct body posture while lifting weights or object. The back-pain injury among workers can be reduced by using belt support while performing lifting jobs. This also can increase human safety in the workplace and reduce the problem related to musculoskeletal disorders (MSDs). To develop low-cost EMG (LCEMG) also helps to monitor muscle activity among works. This shows it can be a preliminary study to indicate low back pain while lifting an object in the workplace especially in the logistic Malaysian context. For a comprehensive analysis and study, the low-cost EMG device can be improved and being tested in various logistics companies such as commercial logistics companies or mail companies. Therefore, further study is needed to verify this initial result obtained in this study.

ACKNOWLEDGMENTS

The authors acknowledge the financial support of Osaka Gas Foundation in Cultural Exchange (OGFICE) Research Grant from Japan (IG/F02/OSAKA/02/2018), Many thanks to all the colleagues, undergraduate students from Universiti Malaysia Sarawak (UNIMAS) and to Universiti Kebangsaan Malaysia (UKM) research grant (GUP-2019-019).

5. REFERENCES

[1] Bernard P. Musculoskeletal Disorders and Workplace Factors: A Critical Review of Epidemiologic Evidence for Work-Related Musculoskeletal Disorders of the Neck, Upper Extremity, and Low Back. in: DHHS (NIOSH) Publication No. 97B141. National Institute for Occupational Safety and Health, Cincinnati, OH 1997: 1-12

[2] Hoy D, Brooks P, Blyth F, Buchbinder R. The Epidemiology of low back pain. J Manipulative Physiol Ther. 2010; **24**: 769-781

[3] Dionne CE, Dunn KM, Croft PR. Does back pain prevalence really decrease with increasing age? A systematic review. Age Ageing. 2006; **35**: 229-234

[4] Haldeman S, Kopansky-Giles D, Hurwitz EL et al. Advancements in the management of spine disorders. J Manipulative Physiol Ther. 2012; **26**: 263-280

[5] Dagenais S, Caro J, Haldeman S. A systematic review of low back pain cost of illness studies in the United States and internationally. Spine J. 2008; **8**: 8-20

[6] Martin BI, Deyo RA, Mirza SK et al. Expenditures and health status among adults with back and neck problems. JAMA. 2008; **299**: 656-664

[7] Luke A, Ma CB. Back and lower extremity injuries. In: Ladou J, Harrison R, editors. Current occupational and environmental medicine. 5th ed. Philadelphia: McGraw-Hill Education; 2014. pp. 97–119.

[8] Rubana H. Chowdhury, Mamun B. I. Reaz, Mohd Alauddin Bin Mohd Ali, Ashrif A. A. Bakar, Kalaivani Chellappan, Tae. G. Chang. Surface Electromyography Signal Processing and Classification Techniques. Sensors (Basel) 2013 Sep; 13(**9**): 12431–12466. Published online 2013 Sep 17.

[9] Kuorinka, L.; Jonson, B.; Kilbom, A.; Viterberg, H.; Bierning-Sorensen, F.; Andersson, G.; Jorgense, K. Standardized Nordic questionnaires for the analysis of musculoskeletal symptoms. Appl. Ergon. 1987, 18, 233–237

[10] Mohd Azrin Mohd Said, Bryan Hansen Wennedy, Ahmad Mu'izz Kadir, Abdullah Yassin, M. Shahidul Islam, Syed Tarmizi Syed Shazali, Hishammudin Afifi Huspi, Ahmad Adzlan Fadzli Khairi, Napsiah Ismail., Empirical Study on Ergonomic for Compact Car Seat and Its Effect to Human Posture. Aust. J. Basic & Appl. Sci., 9(**32**): 299-304, 2015

[11] Ly nn McAtamney and E Nigel Corlett. RULA: a survey method for the investigation of world-related upper limb disorders. Applied Ergonomics 1993. **24**(2): 91-99

[12] Mark Middlesworth. A Step-by-Step Guide Rapid Upper Limb Assessment (RULA). Retrieved from website on 14 October 2020. https://ergo-plus.com/wp-content/uploads/RULA-A-Step-by-Step-Guide1.pdf

[13] Department of Occupational Saftey and Health (2018). Guidelines for Manual Handling at Workplace 2018. https://www.dosh.gov.my/index.php/legislation/guidelines/ergonomic/2959-guidelines-for-manual-handling-at-workplace-2018

[14] ISO 11228-1 (2003) Ergonomics - Manual Handling - Part 1: Lifting and Carrying. International Organization for Standardization, Geneva

[15] Health and Safety Executive. (2013). Making the Best Use of Lifting and Handling Aids. Retrieved from http://www.hse.gov.uk/.

[16] Ehsan Rafeemanesh, Farzad Omidi Kashani, Reza Parvaneh, Fatemeh Ahmadi. A Survey on Low Back Pain Risk Factors in Steel Industry Workers in 2015. Asian Spine J. 2017 Feb; 11(**1**): 44–49. Published online 2017 Feb 17.

[17] Heuch I, Hagen K, Heuch I, Nygaard O, Zwart JA. The impact of body mass index on the prevalence of low back pain: the HUNT study. Spine (Phila Pa 1976) 2010; **35:**764–768.

*For correspondence; E-mail: msmazrin@unimas.my or mohdazrin.unimas@gmail.com