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Comparison An Ergonomic Risk Assessment For Repetitive Work Activities On Automotive Workshop Industries Around Parit Raja

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Abstract: Repetitive work, severe exertion and vibration, as well as psychosocial and organizational factors, have all been linked to the formation of Musculoskeletal Disorders (MSDs). Moreover, previous studies had discovered that Musculoskeletal Disorders (MSDs) was mostly linked to the muscles in the neck, back, arms, and legs. The objective of this study to conduct ergonomic risk assessments on 35 automotive maintenance workers around Parit Raja by using Disabilities of the Arm, Shoulder and Hand (DASH) and Assessment of Repetitive Task (ART), Occupational Repetitive Actions (OCRA), and Job Strain Index (JSI) and to correlate Disabilities of the Arm, Shoulder and Hand (DASH) to Repetitive Task (ART), Occupational Repetitive Actions (OCRA), and Job Strain Index (JSI). Statistical Package for Social Sciences (SPSS) was used in this study to analyse the data obtained and to find the Pearson Correlation, p. The average scores for all these score sheets was 14.68 for Disabilities of the Arm, Shoulder and Hand (DASH), 16.66 for Assessment of Repetitive Task (ART), 21.66 for OCRA and 5.31 for Job Strain Index (JSI). The "p" value of Disabilities of the Arm, Shoulder and Hand (DASH) to Assessment of Repetitive Task (ART) was -0.09, Disabilities of the Arm, Shoulder and Hand (DASH) to Occupational Repetitive Actions (OCRA) was -0.26 and Disabilities of the Arm, Shoulder and Hand (DASH) to Job Strain Index (JSI) was -0.15. The results of the comparison were Assessment of Repetitive Task (ART) had the highest Pearson Correlation to the Disabilities of the Arm, Shoulder and Hand (DASH) followed by Job Strain Index (JSI) and Occupational Repetitive Actions (OCRA). In conclusion, ART tool had the highest correlation to the DASH questionnaire followed by JSI and OCRA tool and ergonomic improvement is needed at the automotive workshop in future related to repetitive work activities.

Keywords: Repetitive Work, Automotive Maintenance Workers, DASH, ART, OCRA

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1. Introduction

In today's workplaces, ergonomic assessment methods are used to assess a variety of factors [1]. Workplace deficiencies lead to the development of musculoskeletal disorders (MSDs), which have financial impacts on individuals, society, and employers [2]. Repetitive work, severe exertion and vibration, as well as psychosocial and organizational factors, have all been linked to the formation of MSD [3][4][5][6]. Worker activities are frequently repetitious and physically demanding. Executing such duties in a repetitive motion might put a burden on their bodies, resulting in weariness, injury, or in the worst-case scenario, permanent handicap [7]. Work-related musculoskeletal disorders (WMSDs) have piqued people's interest in workplace safety and prevention for several years. The majority of the symptoms and impacts on work performance linked with WMSDs are connected to upper limb disorders. The following are specific risk factors: repetitive behaviors, a lack of rest periods, and the presence of multiple risk variables [8]. Numerous work-related risk factors, as well as ergonomic concerns, make it more difficult for the worker to create a suitable balance between exhaustion and their ability to bounce back from it [9]. Carpal Tunnel Syndrome (CTS), Lateral Epicondylitis (LE), De Quervain's Tenosynovitis (DQT), Biceps Tendonitis, Rotator Cuff Strain and Cervicogenic Headache are some examples of WMSDs related to repetitive work [10][11][12][13] [14][15][16][17]. In this study, structured interview session by using the DASH questionnaire, direct observation by using ART Tool, OCRA Scoring Sheet and JSI Work Sheet methods were used to investigate Musculoskeletal Discomfort among workers related to repetitive work. The objective of this study was to determine the relationship between DASH and ART, OCRA and JSI methods.

2. Materials and Methods

Before the study was conducted, the topics of this research has been reviewed so that the topics was following the title and objectives of the research. After the topics does not out of title and objectives, it was proceeded to find and determine the sample size of the research. In this study, the sample size were 35 maintenance workers around Parit Raja. The respondents were given DASH as an interview for their own standing of their health condition. After that, some footage of their working condition were recorded to perform the ergonomic risk assessments. ART, OCRA and JSI have been performed by using a goniometer, force gauge and the data collected on site. The results were recorded and analyzed to compare the ergonomic risk assessment using SPSS and identify their relation to DASH.

2.1 DASH Questionnaire

The DASH Outcome Measure has been condensed into the QuickDASH. The QuickDASH have 11 items. After subtracting one and multiplying by 25, this value is converted to a score out of 100. This adjustment is used to make the score more comparable to other 0-100 scaled measurements. There are two optional modules for the optional modules (Sport/Music or Work), each with four questions in each [18].

2.2 ART Tool

The ART tool was modelled after the Manual handling assessment charts (MAC) model to allow health and safety inspectors to check for frequent handling of light loads or other repetitive duties, as well as the common physical risk factors that can lead to upper limb illnesses (ULDs). This assessment is used mainly to assess body regions such as the neck, lower back and upper limbs [19]. The assessment is divided into four stages which are frequency and repetition of movements, force, awkward posture and additional factors.

2.3 OCRA Checklist

OCRA methods were invented by Occhipinti and Colombini in 1996 to determine the extent to which workers are exposed to tasks that are associated with specific upper-limb injury risk variables (repetitiveness, force, poor posture and motions, lack of recovery periods, and others, defined as "additional"). The OCRA index can predict the likelihood of upper limbs (UL) WMSDs. The OCRA checklist, which is modelled on the OCRA index, is easier to use and is frequently recommended for first evaluation of workstations with repeated responsibilities [20].

2.4 JSI Score Sheet

The JSI is a semi-quantitative analysis tool for detecting high-risk employment by calculating an overall number score. Researchers invented the approach to determine exposure. It's designed to help professional and ergonomic teams predict the likelihood of getting MSDs [21]. Only MSDs of the wrists and hands are included within the Strain Index. It has frequently been used to evaluate hazards and compare different work settings in this small yet important carpal tunnel syndrome subject.

3. Results and Discussion

All the respondents for this research were male which gives a percentage of 100% male. The average age of the respondents were 28 years old (min 28 ± 6.1 years) ranging from 18-41 years. Average height of the respondents were 167.57 cm (min 167.57 ± 6.55 cm) ranging from 152-185 cm and the average weight of the respondents were 67.6 kg (min 67.6 ± 9.75 kg) ranging from 50-90 kg.

Table 1: Personal Information of Respondents

Personal Information	Average	Standard Deviation	Range
Age (years)	28	6.1	18-41
Height (cm)	167.57	6.55	152-185
Weight (kg)	67.6	9.75	50-90

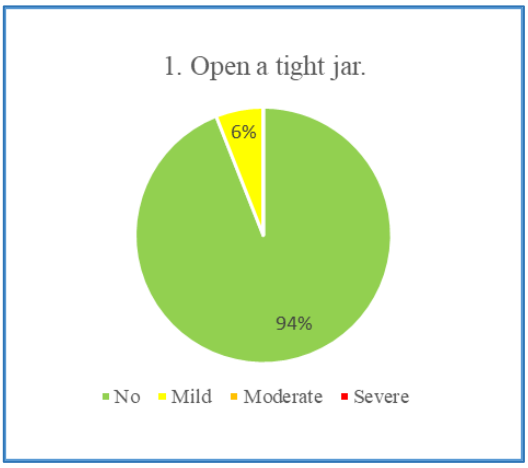
3.1 Results of DASH Questionnaire

The average DASH score obtained was 14.68 out of 100 with the standard deviation of 5.00. An average score as such is considered less risk since the maximum score that could obtain is 100. This statement can be supported by the research done by [22], where they stated that an average DASH score of 47.2 as low risk on their research. The following will be the results of each questions. For the first question on whether or not the respondents are able to open a jar, 94% (N=33) of the respondents answered they have no difficulty. For the second question was about their difficulty on carrying out heavy household chores, 66% (N=23) of the respondents answered they had mild difficulty and 20% (N=7) responded they had moderate difficulties. For the third question on whether or not the respondents can carry a shopping bag or a briefcase, 57% (N=20) responded no difficulties and another 40% (N=14) responded mild difficulties. For the fourth question on whether or not the respondents are able to wash their back, 57% (N=20) of the responded no difficulties and another 43% (N=15) responded with mild difficulties. For the fifth question on whether or not the respondents are able to use a knife to cut their food, 89% (N=31) responded no difficulties and another 11% (N=4) responded with mild difficulties. For the sixth question on whether or not the respondents are able to carry out recreational activities which causes impact, 82% (N=29) responded mild difficulties and another 9% (N=3) responded with moderate difficulties. For the seventh question on whether or not the respondents are able to carry out social activities, 85% (N=30) responded mild difficulties and another 9% (N=3) responded with moderate difficulties. For the eighth question on whether or not the respondents are able to carry out work or regular activities, 68% (N=24) responded no difficulties, 26% (N=9) responded with mild difficulties and another 6% (N=2) responded with moderate difficulties. For the ninth

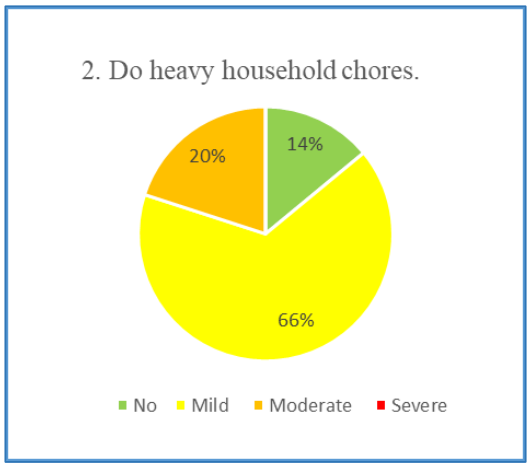
question on whether or not the respondents has arm or hand pain, 62% (N=22) responded mild difficulties, 29% (N=10) responded no difficulties and another 9% (N=3) responded with moderate difficulties. For the tenth question on whether or not they feel any tingling pain, 57% (N=20) responded no difficulties and another 43% (N=15) responded with mild difficulties. For the eleventh question on whether or not the respondents are able to sleep well, 71% (N=25) responded mild difficulties and another 29% (N=10) responded with no difficulties. Below are the figures of pie chart for each question.

Table 2: Average QuickDASH Score for 35 Participants

Score	Average, A	Standard Deviation, s	Range, R
DASH	14.68	5.00	4.55 - 27.27



a



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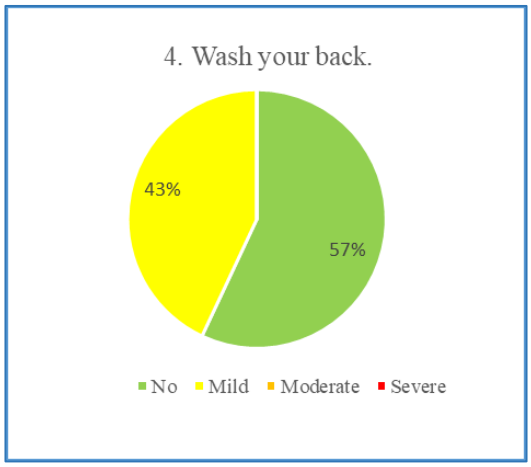
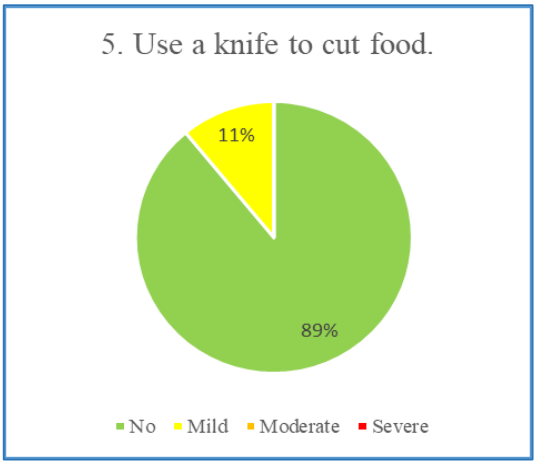
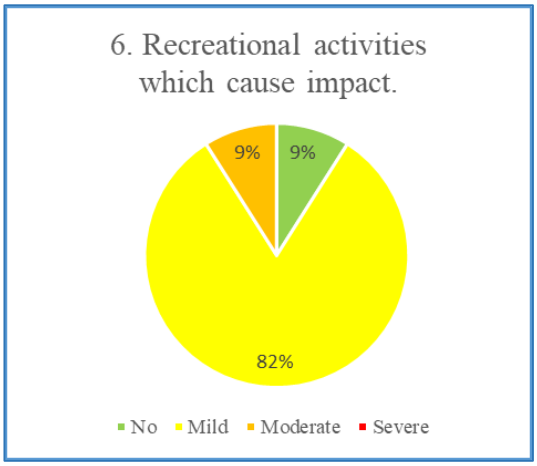


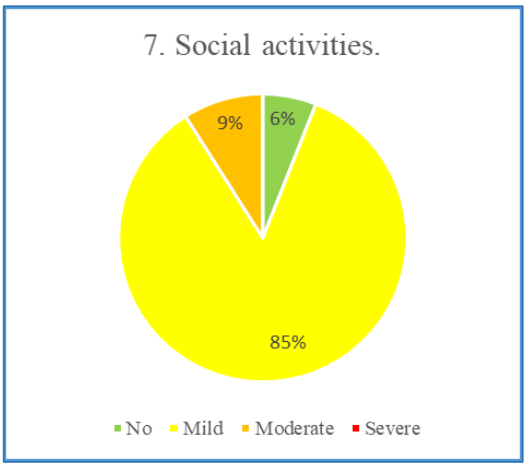
d


5. Use a knife to cut food.
11%
89%
No
Mild
Moderate
Severe

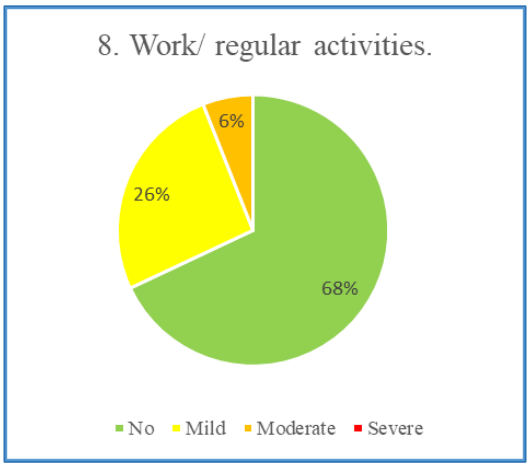
e


6. Recreational activities which cause impact.
9%
9%
82%
No
Mild
Moderate
Severe

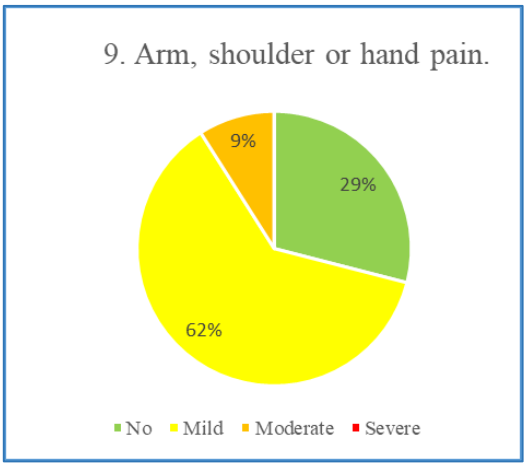
f


7. Social activities.
9%
6%
85%
No
Mild
Moderate
Severe

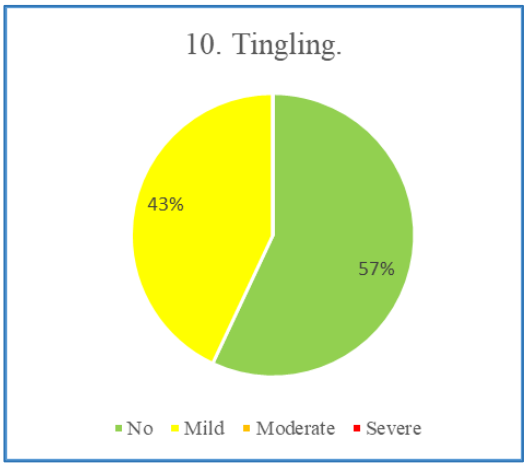
g


8. Work/ regular activities.
6%
26%
68%
No
Mild
Moderate
Severe

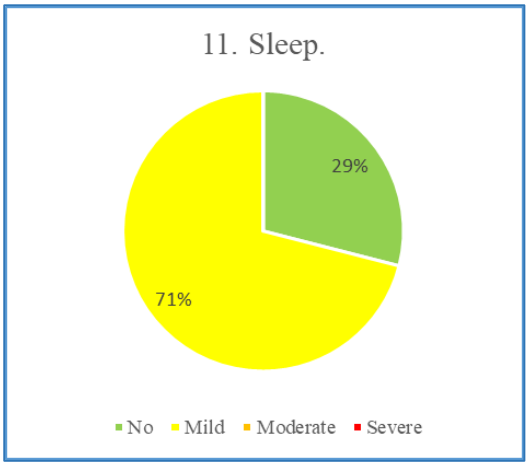
h


9. Arm, shoulder or hand pain.
9%
29%
62%
No
Mild
Moderate
Severe

i


10. Tingling.
43%
57%
No
Mild
Moderate
Severe

j



k

a) Pie Chart for Opening Jar
b) Pie Chart for Doing Heavy Household Course
c) Pie Chart for Carrying Shopping Bag or Briefcase
d) Pie Chart for Washing Back
e) Pie Chart for Using a Knife to Cut Food
f) Pie Chart for Recreational Activities Which Cause Impact
g) Pie Chart for Social Activities
h) Pie Chart for Work or Regular Activities
i) Pie Chart for Arm, Shoulder and Hand Pain
j) Pie Chart for Tingling Pain
k) Pie Chart for Sleeping

Figure 1: Quick DASH Questionnaire Outcome Based on Question

3.2 ART Tool Outcome

The ART Tool flow chart was than filled according to its order to get the exposure score for each individual participants. There are a total of eleven task score which was filled starting with, A1- arm movement, A2 – repetition, B – force, C1 – head/neck posture, C2 – back posture, C3 – arm posture, C4 – wrist posture, C5 – hand/finger grip, D1 – breaks, D2 – work place and D3 – other factors. The task description for each task can be seen in the score sheet which is shown in the Appendix B. The average exposure score shows that the participants are less affected on their left arm compared to their right arm. From this score the researcher also gets to know that majority of the participants are right handed based on the exposure score which shows higher score on the right arm. According to the interpretation of the proposed exposure score, a score between 0-11 means low exposure, score between 12-21 means medium exposure and score of more than 22 which means high exposure and requires urgent further investigation. From the average exposure score, the average score for left arm was 9.31 which is considered low and for right arm was 16.66 which is considered medium. Since the majority of the participants scored low on the left arm doesn't mean that the participants does not have any risk. Adjustments to the work may still be needed to help accommodate each individual. Meanwhile, for the right arm most participant's scores medium which means further investigation on their work is required.

Table 3: Average Exposure Score for Left and Right Arm

Exposure Score	Average, A	Standard Deviation, s	Range, R
Left Arm	9.31	1.99	7 - 13
Right Arm	16.66	2.34	14 - 21

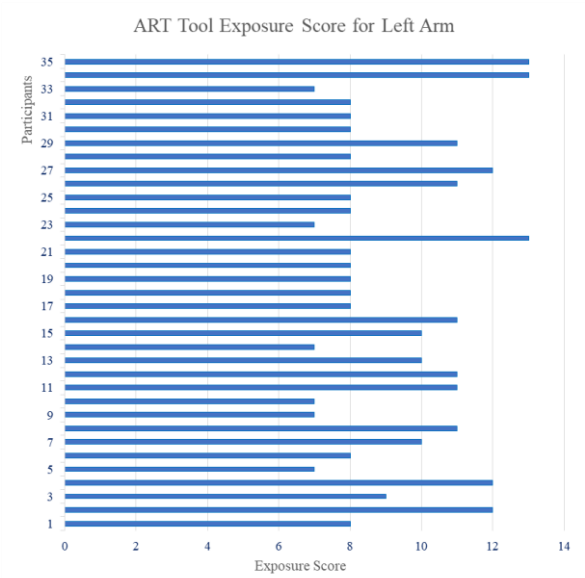


Figure 2: ART Tool Exposure Score for Left Arm

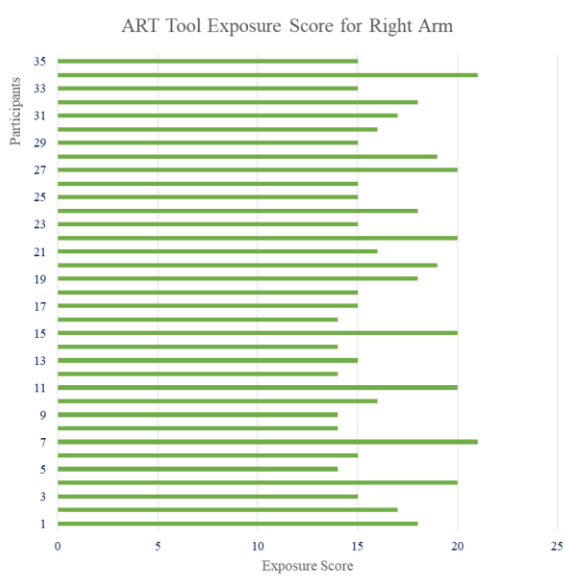


Figure 3: ART Tool Exposure Score for Right Arm

3.3 OCRA Checklist Outcome

The analysis system of the OCRA checklist started with assigning the coded scores for each of the main risk factors (recovery periods, frequency, force, posture, repetitiveness) and for the additional factors. The checklist score was than obtained by summing the frequency, force, posture and additional factors than multiplying the score with recovery period and duration multiplier [23]. According to the results, it is identified that majority of the participants have scored and average of (min 21.66 ± 1.73) for their right side which is in the region of red medium or medium risk. When compared to the left side the participants have scored an average of (min 13.79 ± 1.97) which is in the region of red light or light risk. The checklist scores varies for every participants. For the right side, the lowest score was 18.52 and the highest score was 24.37. Nine participants or 25% of the participants scored more than 22.6 on the checklist score which is at the high risk region. This was mainly due to their awkward wrist posture when reaching for parts in the engine bay.

Table 4: Average OCRA Checklist Score for Left and Right Side of Body

Checklist Score	Average, A	Standard Deviation, s	Range, R
Right Side	21.66	1.73	18.52 – 24.37
Left Side	13.79	1.97	10.73 – 17.23

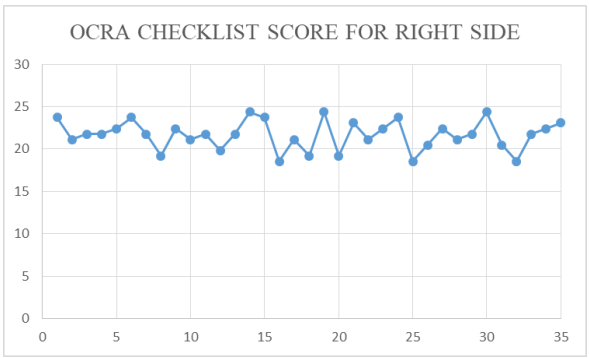


Figure 4: OCRA Checklist Score for Right Side of Body

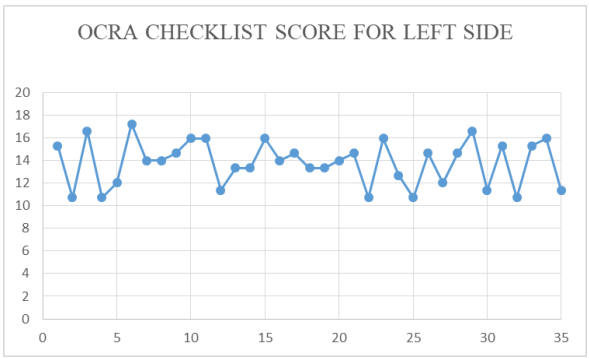


Figure 5: OCRA Checklist Score for Left Side of Body

3.4 JSI Score Sheet Outcome

The JSI score sheet was first filled up in order to get the scores. To calculate the score index for each participants, all the risk factors was multiplied. The formula for the score index is JSI = IE x DE x EM x HWP x SW x DD. The score index was calculated separately for left hand and right hand. From the scores obtained, it is shown that the average score for the left hand was (min 0.63 ± 1.07) and for the right hand was (min 5.31 ± 1.97). Preliminary testing has revealed that jobs associated with the upper extremity disorders had SI Scores greater than 5 [24]. The statement from the author proves that majority of the participants are exposed to the upper extremity disorders for their right hand. The average score shows that the participants are safer for their left hand but on their right hand is stated that the participants are at risk of ULD's. It is because, almost all the participants perform major task such as tools handling and lifting by using their right hand.

Table 5: Average Score index for Left and Right Hand

Score Index	Average, A	Standard Deviation, s	Range, R
Left Hand	0.63	1.07	0.25 – 4.50
Rigt Hand	5.31	1.97	3.00 – 9.00

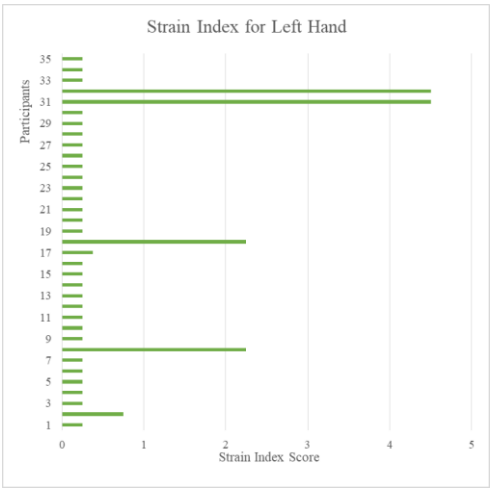


Figure 6: Strain Index for Left Hand

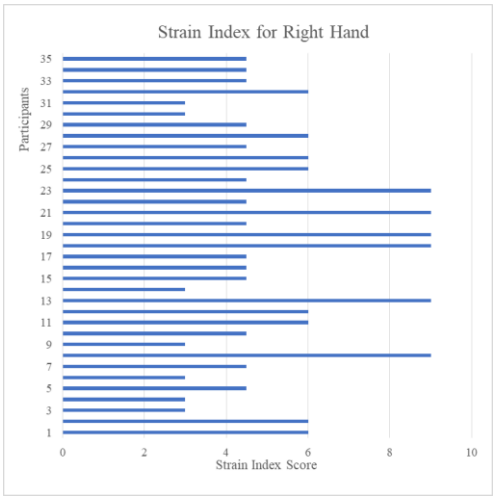


Figure 7: Strain Index for Right Hand

3.5 Correlation between DASH and ART, OCRA and JSI

Once the data for each of the questionnaire and assessments were obtained, the total score of each respondents were compared by using SPSS. Since the data collected were mostly about the upper extremity which includes the arm, neck, wrist and shoulder, the total score was used for comparison since it includes these areas of body. For the total score, ART, OCRA and JSI have a negative correlation to DASH. ART have the highest correlation compared to OCRA and JSI where ART is -0.09 followed by JSI -0.15 and OCRA -0.26. Since the value of Pearson Correlation are in negative meaning that the variables tend to move in opposite direction. A correlation value of -0.8 or lower denotes a significant negative link, whereas for -0.3 or lower denotes a negligibly weak relationship. This statement proves that that all the scores of ART, OCRA and JSI can still be considered as slightly related in consideration that the score of DASH was obtained by the response from the respondents themselves [25][26].

The significant level of ART is the highest compared to OCRA and JSI which are 0.59 for ART, 0.39 for JSI and finally 0.13 for OCRA. Mean of scores for each methods are, DASH (14.68), ART

(16.66), OCRA (21.66) and JSI (5.31). Standard deviation for each methods are, DASH (5.00), ART (2.34), OCRA (1.73) and JSI (1.97).

Table 6: Descriptive Statistics and Correlation

Method	Mean	Standard Deviation	ρ	Sig.	N
DASH	14.68	5.00	1	-	35
ART	16.66	2.34	-0.09	0.59	35
OCRA	21.66	1.73	-0.26	0.13	35
JSI	5.31	1.97	-0.15	0.39	35

4. Conclusion

There were three objectives for this research. The first objective was to investigate MSD among workers related to repetitive work using DASH. DASH was used to conduct a survey among the workers related to repetitive work before conducting the ERA. The average DASH score obtained was 14.68 out of 100 with the standard deviation of 5.00. This objective was achieved since the data has been collected and analyzed.

The second objective was to assess an ERA among workers related to repetitive work by using ART, OCRA and JSI methods. This was done by using the observation method with the aid of tools such as video camera, weighing scale and goniometer. For the average exposure score of ART, the average score for left arm was 9.31 which is considered low and for right arm was 16.66 which is considered medium. For the scores obtained for OCRA, it is shown that the average score for the left hand was 13.79 which is light risk and for the right hand was 21.66 which is medium risk. For the scores obtained for JSI, it is shown that the average score for the left hand was 0.63 which is low risk and for the right hand was 5.31 which is medium risk. This objective was also achieved since the data was able to be collected and analyzed.

The third objective was to determine the relationship between DASH and ART, OCRA and JSI methods. The scores of each participants for DASH, ART, OCRA and JSI were organized by using Excel so that it will be easy and not complicated when comparing by using SPSS. ART have the highest correlation compared to OCRA and JSI where ART is -0.09 followed by JSI -0.15 and OCRA -0.26. The significant level of ART is the highest compared to OCRA and JSI which are 0.59 for ART, 0.39 for JSI and finally 0.13 for OCRA. This objective was also achieved since the correlation was done successfully and the significance can be shown.

Acknowledgement

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References

[1] Takala E-P, Pehkonen I. Systematic evaluation of observational methods assessing biomechanical exposures at work. Scandinavian journal of work, environment & health. 2010; 15 (2):3-24.

[2] Bovenzi M, Zadini A, Franzinelli A, Borgogni F [1991]. Occupational mus-culoskeletal disorders in the neck and upper limbs of forestry workers exposed to hand-arm vibration. Ergonomics 34(5): 547–562.

[3] Palmer, K. T., & Smedley, J. (2007). Work relatedness of chronic neck pain with physical findings—a systematic review. Scandinavian journal of work, environment & health, 165-191.

[4] Van Rijn, R. M., Huisstede, B. M., Koes, B. W., & Burdorf, A. (2009). Associations between work-related factors and the carpal tunnel syndrome—a systematic review. Scandinavian journal of work, environment & health, 19-36.

[5] Bongers PM. The cost of shoulder pain at work. BMJ. 2001 Jan 13; 322 (7278):64–65.

[6] Andersen JH, Gaardboe O. Musculoskeletal disorders of the neck and upperlimb among sewing machine operators: a clinical investigation. Am J Ind Med 1993:692- 700.

[7] Lop, N. S. B., Salleh, N. M., Zain, F. M. Y., & Saidin, M. T. (2019). Ergonomic RISK FACTors (ERF) and their Association with Musculoskeletal Disorders (MSDs) among Malaysian construction trade workers: concreters. Int J Acad Res Bus Soc Sci, 9(9), 1269-1282.

[8] Steven Moore J, Garg A. The strain index: a proposed method to analyze jobs for risk of distal upper extremity disorders. American Industrial Hygiene Association. 1995; 56(1):443-58.

[9] Beaton, D. E., Davis, A. M., Hudak, P., & McConnell, S. (2001). The DASH (Disabilities of the Arm, Shoulder and Hand) outcome measure: what do we know about it now?. The British Journal of Hand Therapy, 6(4), 109-118.

[10] Slenker NR, Lawson K, Ciccotti MG, Dodson CC, Cohen SB. Biceps tenotomy versus tenodesis: clinical outcomes. Arthroscopy 2012 Apr;28(4):576e82

[11] Shiri R, Viikari-Juntura E, Varonen H, Heliövaara M. Prevalence and determinants of lateral and medial epicondylitis: a population study. Am J Epidemiol 2006; 164:1065-74.

[12] Sun, Y., Nimbarte, A.D., Motabar, H., 2017. Physical risk factors associated with the work-related neck/cervical musculoskeletal disorders: a review. Ind. Syst. Eng. Rev. 5 (1), 44–60.

[13] McDonald, A.C., Calvin, T.F., Keir, P.J., 2016. Adaptations to isolated shoulder fatigue during simulated repetitive work. Part II: Recovery. J. Electromyogr. Kinesiol. 29, 42–49.

[14] Ilyas AM, Ast M, Schaffer AA, Thoder J. De Quervain tenosynovitis of the wrist. J Am Acad Orthop Surg 2007;15(12):757–764.

[15] Hsu AR, Ghodadra NS, Provencher MT, Lewis PB, Bach BR (2011). Biceps tenotomy versus tenodesis: a review of clinical outcomes and biomechanical results. J Shoulder Elb Surg 2011 Mar;20(2):326e32.

[16] Galdi B, Southren DL, Brabston EW, Popkin CA, Jobin CM, Levine WN, Ahmad CS. Patients have strong preferences and perceptions for bicepstenotomy versus tenodesis. Arthroscopy 2016 Dec;32(12):2444e50.

[17] Hamilton PG. The prevalence of humeral epicondylitis: a survey in general practice. Br J Gen Pract 1986;36:464-5.

[18] Ferreira J, Gray M. Development of an assessment tool for repetitive tasks of the upper limbs (ART). 2009;11-12.

[19] Colombini D, Occhipinti E. Updating of application procedures and criteria for OCRA Checklist. Med Del Lav. 2011;102(3):1-39.

[20] Moore JS, Garg A. Participatory ergonomics in a red meat packing plant. Part II: case studies. Am Ind Hyg Assoc J. 1997; 58(7):498–508.

[21] Kazmers, N. H., Qiu, Y., Yoo, M., Stephens, A. R., Tyser, A. R., & Zhang, Y.(2020). The minimal clinically important difference of the Promis and QuickDASH instruments in a nonshoulder hand and upper extremity patient population. The Journal of Hand Surgery, 45(5).

[22] Colombini D, Occhipinti E. (2002) Risk assessment and management of repetitive movements and exertions of upper limbs: job analysis. OCRA Risk Indicies, Prevention Strategiesand Design Principles: Elsevier Science2002.83-91.

[23] Moore JS. De Quervain's tenosynovitis: stenosing tenosynovitis of the first dorsal compartment. J Occup Environ Med 1997;39(10):990- 1002.

[24] McDonald, A.C., Calvin, T.F., Keir, P.J., 2016. Adaptations to isolated shoulder fatigue during simulated repetitive work. Part II: Recovery. J. Electromyogr. Kinesiol. 29, 42–49

[25] Dasgupta, P.S., Punnett, L., Moir, S., Kuhn, S., Buchholz, B., 2016. Does drywall installers' innovative idea reduce the ergonomic exposures of ceiling installation: A field case study. Applied ergonomics 55, 183–193.

[26] Korhonen T, Ketola R, Toivonen R, Luukkonen R, Häkkänen M, Viikari-Juntura E. Work-related and individual predictors for incident neck pain among office employees working with video display units. Occup Environ Med 2003;60:475-82.