

Musculoskeletal Discomfort Evaluation using Rapid Entire Body Assessment (REBA) and Quick Exposure Check (QEC) among Woodworking Workers in Selangor, Malaysia

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ABSTRACT----

Objective: *This study aims to investigate the exposure to risk factors for WMSDs using Quick Exposure Check (QEC) and Rapid Entire Body Assessment (REBA) in woodworking workers with four main tasks, including cutting, lifting, assembling, and finishing products.*

Background: *Work-related musculoskeletal disorders (WMSDs) are one of the major occupational health problems among woodworkers, especially in developed and developing countries, such as Malaysia. Recently, numerous studies on MSDs have been widely explored, yet the culture, environment and regulatory practices on hazard and risk may differ in each country.*

Method: *The study was conducted on 30 workers in 3 woodworking workshops in Selangor, Malaysia. Through this study, demographic surveys, QEC, and REBA were examined.*

Results: *The results indicated that the most critical task is the lifting and assembling activity.*

Conclusion: *These two activities may require an ergonomic intervention to reduce WMSDs risks.*

Keywords---- Work-related musculoskeletal disorders (WMSDs), woodworking workers, risk factors, QEC, REBA

1. INTRODUCTION

Musculoskeletal disorders (MSDs) are injuries or pain involved with body muscles, bones, and joints. Work-related musculoskeletal disorders (WMSDs) are associated with work performance and environment that significantly to these conditions. It involves awkward posture, prolonged sitting and standing, repetitive movements, and lifting heavy objects. WMSDs are one of the most encountered health problems in almost every sector globally. In Malaysia, the furniture manufacturing sector is growing rapidly (1), and according to the Malaysian Investment Development Authority (MIDA), this sector contributes almost 40% of the wood-based industry's total export earnings (2). However, despite the health and safety of the large furniture manufacturing industry, Fabiano et al. (2004) indicated that workers in small business enterprises are highly exposed to health and safety risks due to difficulty in assessing and controlling them (4,5). Work-related risk factors for woodworking include physical demands imposed by prolonged standing, repetitive motions, vibration, noise, and heavy tasks. Several studies have reported WMSDs in the woodworking industries (6–8), and several observational techniques were developed for assessing risk factors related to WMSDs (9,10). The Quick Exposure Check (QEC) evaluates physical workplace factors, which involve four main body parts to be assessed, as well as psychosocial factors (11). Meanwhile, Rapid Entire Body Assessment (REBA) is a postural analysis that evaluates the MSDs risks in various tasks (12). The QEC involves practitioners and workers in the assessment and allows the four main body parts, i.e., back, shoulder/arm, wrist/hand and neck, to be assessed because these parts are prone to work-related injuries (13). Primarily, the tool focuses on physical workplace factors, as well as the evaluation of psychosocial factors. It has scoring

data and exposure levels systems. Subsequently, it should be used to evaluate the effectiveness of any intervention made. The REBA is an inexpensive observational tool, easy to use, and does not interfere with workers' tasks being assessed. It is one of the most frequent techniques for assessing the postural body applied in the industry (14,15). QEC and REBA are suitable methods for identifying risks in the job and determining the potential risks for WMSDs (9). This present study aims to investigate the risk factor for WMSDs using REBA and QEC in woodworking workers in four main activities, including cutting, lifting, assembling, and finishing products. According to the Occupational Safety and Health Association (2013), to design the workspace, it should be approximately 15% or less of workers' maximum capacity. Hence, the working area, tools and equipment should be designed ergonomically to minimise MSDs risk and fatigue and reduce the amount of effort exerted on the muscles of workers. Therefore, the result will be used to develop the conceptual ergonomic design for industrial workers in the activity of the most affected task being assessed.

2. MATERIAL AND METHODS

Study design and procedure

This study used the observational analytical study involving demographic, QEC and REBA. The study was conducted over four months, between January to April 2022. The study was performed in three small-sized woodworking workshops in Selangor, Malaysia. The selected woodworking tasks for this assessment are cutting, assembling, lifting, and finishing products.

Participants

Thirty participants were involved in this study. All participants work as carpenters. According to UNESCO (2021), the job scope of a carpenter is constructing, installing, or repairing structures, fittings, or furniture made of wood and building frameworks, including partitions, joists, struts and rafters, wood staircases, window and door frames, and hardwood floors using their skills and tools.

Data collection

The demographic data were recorded using a questionnaire. Demographic details include age, gender, marital status, smoking habit, long working hours, and current task of the respondents. In addition to these data, REBA and QEC were used to evaluate the working posture of workers while performing their tasks. REBA was used to identify the most critical tasks faced by woodworking workers. It is an observation method aimed at rapid assessment of tasks with minimal training of the observer. REBA requires the observer to identify workers by screening the whole body to assess postural loading on the body while performing specific tasks within a job. Meanwhile, QEC is used to identify the most critical tasks faced by woodworking workers. It allows physical work activities to be assessed in collaboration with the worker. QEC is designed to be quick and easy and requires minimal training from the observer. QEC and REBA are reliable and validated observational methods used to assess the postural measurement of the musculoskeletal system, which can contribute to WMSDs. Table 1 shows the interpretation of REBA scores, and Table 2 shows the interpretation of QEC scores. Each task performance was recorded by a video camera to verify the results.

Table 1. Interpretation of REBA scores (12)

Score	Level of MSD Risk
1	Negligible risk, no action required
2 to 3	Low risk, change may be needed
4 to 7	Medium risk, further investigation, change soon
8 to 10	High risk, investigate and implement change
11 to 15	Very high risk, implement change

Table 2. Interpretation of QEC score (18)

Score	Exposure level			
	Low	Moderate	High	Very High
Back (static)	8 - 15	16-22	23 - 29	29 - 40
Back (moving)	10 - 20	21 - 30	31 - 40	41 - 56
Shoulder/arm	10 - 20	21 - 30	31 - 40	41 - 56
Wrist/hand	10 - 20	21 - 30	31 - 40	41 - 46
Neck	4 - 6	8 - 10	12 - 14	16 - 18
Driving	1	4	9	-
Vibration	1	4	9	-
Work pace	1	4	9	-
Stress	1	4	9	16

3. RESULT

Demographic

A total of 30 woodworking workers participated in this study. The age, marital status, smoker status, daily working hours, current working experience in years, and work experience in years are summarised in Table 3.

Table 3. Demographic of the study subjects.

	<i>N</i>	<i>%</i>	<i>Mean</i>	<i>SD</i>				
					<i>Daily Working Hours</i>			
					<8 hrs	8	26.7	
					>8 hrs	22	73.3	
					<i>Current Working Experience (in years)</i>			
					1 to 5	23	76.6	(4.43)
					6 to 10	5	16.7	(4.614)
					11 to 15			
					16 to 20	2	6.7	
					<i>Working Experience (in years)</i>			
					1 to 5	13	43.3	(8.67)
					6 to 10	6	20	(6.939)
					11 to 15	4	13.3	
					16 to 20	5	16.7	
					<21	2	6.7	
					<i>Demographic of the study subjects</i>			
					<i>Gender</i>			
					Male	27	90	
					Female	3	10	
					<i>Age</i>			
					20 -30	16	53.3	(31.83)
					31 - 40	9	30.1	(6.939)
					<41	5	16.7	
					<i>Marital status</i>			
					Married	15	50	
					Single	15	50	
					<i>Smoker status</i>			
					Yes	14	46.7	
					No	16	53.3	

REBA and QEC assessments of working postures

Cutting activity

Table 4 shows the exposure level (REBA) for cutting activity. In this activity, 8 workers scored medium level for the current task, which requires necessary changes on the current workstation.

Table 4. Exposure level (REBA) for cutting activity.

REBA	Score		
1	Negligible	-	Non necessary
2 to 3	Low	-	Maybe necessary
4 to 7	Medium	8	Necessary
8 to 10	High	-	Necessary soon
11 to 15	Very high	-	Necessary NOW
Total		8	

Table 5 indicates the exposure level for QEC scoring in cutting activity, while Table 6 indicates similar scoring for other factors in the activity.

Table 5. Exposure level (QEC) for cutting activity.

	Back (static)	Back (moving)	Shoulder/ arm	Wrist/ hand	Neck
Score	-	30 (±6.0)	27.78 (±6.0)	26 (±5.4)	10.89 (±2.2)
Exposure level	-	Moderate	Moderate	Moderate	Moderate

The results of our study indicate that woodworking workers have moderate scores of risk exposures for all regions in the cutting activity.

Table 6. Exposure level (QEC) for other factors for cutting activity.

Score	Driving		Vibration		Working pace		Stress	
	N	%	N	%	N	%	N	%
1	7	87.5	4	50	5	62.5	5	62.5
4	1	12.5	4	50	3	37.5	3	37.5
9	-	-	-	-	-	-	-	-
16	-	-	-	-	-	-	-	-
Total	8	100	8	100	8	100	8	100

From the table, 7 workers (87.5%) have low exposure levels for driving scores, 4 (50%) showed low and moderate levels for vibration, and 5 (62.5%) showed low exposure levels for work pace and stress.

Assembling activity

Table 7 shows the REBA scoring for the assembling activity. In this activity, 2 workers scored medium level, 3 scored high level, and 4 scored very high level for the current task. The very high level requires necessary urgent changing of the current workstation.

Table 7. Exposure level (REBA) for assembling activity.

REBA	Score		
1	Negligible	-	Non necessary
2 to 3	Low	-	Maybe necessary
4 to 7	Medium	2	Necessary
8 to 10	High	3	Necessary soon
11 to 15	Very high	4	Necessary NOW
Total		9	

Table 8 indicates the exposure level for QEC scoring in the assembling activity, while Table 9 indicates similar scoring for other factors in the same activity.

Table 8. Exposure level (QEC) for assembling activity.

	Back (static)	Back (moving)	Shoulder/ arm	Wrist/ hand	Neck
Score	24 (± 12.1)	28.67 (± 10.2)	32 (± 11.6)	26.89 (± 9.0)	10.89 (± 4.1)
Exposure level	High	Moderate	High	Moderate	Moderate

The results of our study indicate that woodworking workers have high scores of risk exposures for the back (static) and shoulder/arm in the assembling activity. However, the risk exposures for the back (moving), wrist/hand and neck are moderate.

Table 9. Exposure level (QEC) for other factors for assembling activity.

Score	Driving		Vibration		Working pace		Stress	
	N	%	N	%	N	%	N	%
1	6	66.7	5	55.6	6	66.7	4	44.4
4	3	33.3	4	44.4	3	33.3	5	55.6
9	-	-	-	-	-	-	-	-
16	-	-	-	-	-	-	-	-
Total	9	100	9	100	9	100	9	100

In this activity, 6 workers (66.7%) had a low exposure level in the driving score, 5 (55.6%) showed a low exposure level in vibration, 6 (66.7%) showed a low exposure level in work pace, and 5 (55.6%) showed moderate exposure level in stress.

Lifting activity

Table 10 shows the REBA scoring for lifting activity. In this activity, 2 workers scored high level, and 6 scored very high level for the current task. The very high level requires necessary urgent changing of the current workstation.

Table 10. Exposure level (REBA) for lifting activity.

REBA	Score
1	Negligible - Non necessary
2 to 3	Low - Maybe necessary
4 to 7	Medium - Necessary
8 to 10	High 2 Necessary soon
11 to 15	Very high 6 Necessary NOW
Total	8

Table 11 indicates the QEC scoring in lifting activity, while Table 12 indicates the exposure level for QEC scoring for other factors in lifting activity.

Table 11. Exposure level (QEC) for lifting activity.

	Back (static)	Back (moving)	Shoulder/ arm	Wrist/ hand	Neck
Score	-	35.25 (± 4.6)	33.5 (± 3.9)	25.5 (± 1.7)	10.25 (± 0.7)
Exposure level	-	Very high	High	Moderate	Moderate

The results of our study indicate that woodworking workers have very high scores of risk exposures for the back (moving), high scores of risk exposures for shoulder/arm, and moderate for wrist/hand and neck for the lifting activity.

Table 12. Exposure level (QEC) for other factors for lifting activity.

Score	Driving		Vibration		Working pace		Stress	
	N	%	N	%	N	%	N	%
1	8	100	8	100	7	87.5	7	87.5
4	-	-	-	-	1	12.5	1	12.5
9	-	-	-	-	-	-	-	-
16	-	-	-	-	-	-	-	-
Total	8	100	8	100	8	100	8	100

In this activity, 8 (100%) showed a low exposure level in the driving score, 8 (100%) showed a low exposure level in vibration, and 7 (87.5%) showed a low exposure level in work pace and stress.

Finishing activity

Table 13 shows the REBA scoring for the finishing activity. In this activity, 3 workers scored medium level, while 2 scored high level for the current task. The high level requires necessary urgent changing of the current workstation.

Table 13. Exposure level (REBA) for finishing activity.

REBA	Score	
1	Negligible	Non necessary
2 to 3	Low	Maybe necessary
4 to 7	Medium	3 Necessary
8 to 10	High	2 Necessary soon
11 to 15	Very high	Necessary NOW
Total	5	

Table 14 indicates the exposure level for QEC scoring in the finishing activity, while Table 15 indicates similar scoring for other factors in the same activity.

Table 14. Exposure level (QEC) for finishing activity.

	Back (static)	Back (moving)	Shoulder/arm	Wrist/hand	Neck
Score	22.8 (±5.9)	-	27.6 (±5.5)	25.6 (±7.2)	13.6 (±2.1)
Exposure level	Moderate	-	Moderate	Moderate	High

The results of our study indicate that woodworking workers have high scores of risk exposure in the neck (13.6 ± 2.1) for the finishing activity. However, the back (static), shoulder/arm, and wrist/hand scores are moderate, with 22.8 ± 5.9 , 27.6 ± 5.5 , and 25.6 ± 7.2 .

Table 15. Exposure level (QEC) for other factors for finishing activity.

Score	Driving		Vibration		Working pace		Stress	
	N	%	N	%	N	%	N	%
1	4	80	4	80	-	-	-	-
4	1	20	1	20	5	100	2	40
9	-	-	-	-	-	-	-	-
16	-	-	-	-	-	-	3	60
Total	5	100	5	100	5	100	5	100

The tables indicate that 4 (80%) workers showed a low exposure level in the driving score, 4 (80%) showed a low exposure level in vibration, and 5 (100%) showed work pace with moderate exposure level. However, 3 (60%) showed very high exposure levels in the stress category.

4. DISCUSSION

The furniture manufacturing industry is considered a 3D industry, representing dirty, dangerous, and degenerative (1). Thus, it requires a high level of strength and attention while performing the tasks. This study was conducted to investigate the exposure of risk factors for WMSDs using two established assessments, REBA and QEC, among woodworking workers in four main activities, i.e., cutting, lifting, assembling, and finishing products. The results of this study described the risk factor for each activity. However, the REBA results indicated that lifting and assembling activities required necessary urgent changes to the current workstation, while the most affected body region according to QEC was the back and shoulder for lifting (back = 35.25 ± 4.6 ; shoulder = 33.5 ± 3.9) and assembling (back = 35.25 ± 4.6 ; shoulder = 33.5 ± 3.9) activities. In addition, the most awkward posture of the workers was the bending posture lifting goods and assembling products.

Lifting is an activity of moving from a lower to a higher place or position requiring workers to involve bending, awkward posture and repetitive movement to carry the objects. However, overexertion and cumulative trauma were the highest factors in lifting injuries. Isa (2021) evidences that lifting was the most used movement by the manufacturing workers (19). Several studies have reported that lifting causes MSDs (20,21). In addition, the repeating movement may give a negative impact on MSDs when involving the strain that develops or accumulate over time (22–24), as well as prolonged heavy lifting (25) and awkward working position. A study among woodworkers in Southwestern Nigeria revealed that lifting heavy objects was the major risk factor (26). Among studies performed in similar industries, the REBA scores were very high in the sections manual lifting (27).

Assembling is fabricating and joining the parts to construct a final product that requires workers to perform prolonged awkward posture while standing or sitting. The greater rate was reported in the knees, lower back and wrists/hands among workers of furniture workshops (28), related to assembly activities in furniture workshops due to manual material handling, poor workstation design and awkward working postures. Furthermore, Hashim et al. (2012) reported that assembly activity has the highest score in school wood workshops. Meanwhile, assembly line workers from the manufacturing industry indicated the highest score in back pain (30–32), which required heavy force from workers performing manual handling.

In biomechanical, the spine and soft tissue could be damaged due to continuous vibration, working pace and work stress. Driving, vibration, working pace, and work stress scores were low to moderate in almost all activities, except for finishing activities, with very high work stress. The finishing activity exhibited a very high stress level because the workers must focus on their tasks. Björning and Hägg (2000) reported that the spray paint task caused the most uncomfortable and strenuous work postures, leading to stress. A similar task by Shanmugam et al. (2021) found that spray painters experienced the highest discomfort due to an improper workstation and MSD pain.

Previous studies revealed that the most affected body parts are the back, shoulders, arms, wrists, fingers, and neck (25,35–37). Ergonomic interventions are very important to minimise the risks of WMSDs (38,39) and reduce the physical strain of the MSDs and the risk of injury (40). For example, equipment such as tables or platforms could facilitate the workers involved in lifting and carrying wooden products and planks (41). The previous studies are significant to our present findings, which indicate the high risk exposure of lifting and assembling activities. Thus, based on the results of this study, the following ergonomic interventions are recommended to improve the working environment and minimise postural risk factors while lifting and assembling products:

Lifting;

- Industrial trolley to carry heavy objects
- Appropriate equipment following worker's anthropometric
- Schedule on lifting object task cycle
- Training workers to minimise WMSD risk factors

Assembling;

- Providing personal protective equipment (PPE) for workers
- Adjustable table by following worker's anthropometric
- Optimising workspace layout
- Schedule on work-rest cycle
- Training workers in order to minimise the WMSD risk factors

Finishing;

- Schedule on work-rest cycle
- Application on the anthropometric workstation
- Training workers in order to reduce stress

5. CONCLUSION

This study revealed the association between different tasks and the occurrence of WMSDs among woodworking industries. In conclusion, the results of the two assessments above indicate that the most critical affecting task is the lifting and assembling activity. Thus, we decide to investigate this activity further. Moreover, the results provide a perspective on how to improve work conditions, the design of equipment, and workplace layout area to minimise the complaints among woodworking workers about MSDs.

6. DISCLOSURE STATEMENT

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of this article.

7. ACKNOWLEDGEMENT

The authors gratefully acknowledge the financial support of Graduate Research Fellowship (GRF), Universiti Putra Malaysia.

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