ORIGINAL ARTICLE

VALIDITY TEST FOR SIMPLE ERGONOMICS RISK ASSESSMENT (SERA) METHOD

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ABSTRACT
Validity test is important during the development of ergonomics measurement. Failure to conduct validity tests will result in the measurement method being developed to be incapable of providing reliable ergonomics measurements. The objective of this study is to conduct validity test on the simple method ergonomics measurement which was developed. The method named Simple Ergonomics Risks Assessment (SERA). Content validity test and criterion validity test were conducted. The content validity test consists of 6 ergonomics experts who actively provide inputs and positive feedbacks to improve the measurement method being developed. Meanwhile, the criterion validity test involves data collection of complaints on body parts among oil palm workers which were derived from Nordic Musculoskeletal Questionnaire (NMQ) and ergonomics risk assessment scores obtained from SERA. Both findings were tested with the Chi-square test to explore possible relations between the two findings. Results from the test conducted showed that there are significant relations in the scores of neck posture; hip, right and left shoulder, right and left wrists and the right hand associated with fresh fruit bunch (FFB) harvesting activities. In the loose fruits collection, the Chi-square test showed significant relations in the scores of neck posture, hip, right and left shoulders, right wrist, right arm and the left hand. However, there are body parts such as the legs which showed no significant relation. More tests should be conducted to further explore the validity of the method being developed. Findings from both validity tests show that SERA were verified by the experts and tested with validated method so that it is valid to be applied in the future.

Keywords: *Ergonomics measurement method, pen and paper based, content validity test, criteria validity test*

INTRODUCTION

Psychometric properties assessment on the ergonomics measurement method being developed is important to validate the measurement tools to ensure it can be used in ergonomics risk management. Ergonomics measurement method with good psychometric properties value indicates that it was properly developed and tested so that it is can be widely used by researchers[1]. That is why, the issue of reliability and validity in the development of ergonomics measurement methods received considerable attention for the past decade[2]. This is particularly so in the development of pen and paper based ergonomics measurement method as both the reliability and validity testing are mandatory especially in exploring the relationship between ergonomics risk factors and the health effects particularly those involving musculoskeletal disorders (MSDs)[3,4,5,6,7]. Failure to do so, will lead to inconsistent and inaccurate measurements.

During the initial development stage of SERA method, a thorough literature studies was conducted. Literature studies on ergonomics risk factors in the plantation sector were carried out[8].Previously developed ergonomics measurement methods having the same objectives with SERA were explored and thoroughly analysed[9].Additionally, the researchers also discussed with focus group members who are researchers in ergonomics fields from three local universities to determine relevant ergonomics risk factors in SERA. Focus group meetings were also held in previous researches[10,11].Target population were interviewed by the researchers on severaloccasions[12,13] to gain important inputs in developing the conceptual model for the SERA method. This technique is also suggested by Giesleret al.[14].

Validity is an important psychometric property in assessing a measurement method being developed[1]. Validity test is crucial in ensuring the method is capable of measuring what it sets out tomeasure[15]. There are several types of validity test such as content validity and criterion validity.

Content Validity

A content validity assessment is important in the process of developing a new ergonomics measurement method[1].There are two approaches used to test content validity[16]. They are: (1) Assessment through face validity and (2) Assessment throughexperts' assessment. In a previous study by Lafaveet al.[17], they conducted content validity test with the involvement of experts committee. The experts committee should consist of 5 to 10 experts[18,19]. Assessment of content validity of a measurement method being developed can also be carried out

qualitatively[16]. In this study, the content validity test is carried out to fulfil the following objectives: (1) getting experts' opinion on the content of the method being developed, so that irrelevant factors can be identified and eliminated from the measurement method[20]; and (2) getting feedbacks from experts on the measurement method from the standpoint of words used or relevant illustrations[21].

Criterion Validity

Criterion validity is also tested in this study. Criterion validity test refers to the test conductedon the method being developed by comparing it with current available methods.

METHODS

Research subjects

Six ergonomics experts aged between 30 - 58 who are actively doing research at the Faculty of Engineering and Built Environment,

Current available methods refer to previously developed methods which are regarded as 'gold standard' (tested and proven) in assessing ergonomics risks factors and having the same objectives as the method being developed[1].

This is to ensure that the SERA method is capable of producing findings that are parallel with the method used as reference. Previous studies showed that the criterion validity tests were carried out by every researcher involved in developing ergonomics measurement methods[7]. Table 1 shows how previous researchers conducted criterion validity tests on their measurement methods.

discussions between observers are not allowed to ensure each observer applied the method being developed without any assistance. This also helped them to focus and provide honest observation and opinion. Problems and confusions in the application of the method can be effectively identified in the individual assessment compared to group assessment where

Table 1 Reference list of published criterion validity test

References	Method	Validity test
Teschke et al.[22]	Back Injuries in Heavy Industries (Back EST)	Back EST anddirect measurement score (Inclinometer)
Rahman et al.[23]	Workplace Ergonomics Risk Assessment (WERA)	WERA and body parts discomfort score [24]
David et al.[25]	Quick Exposure Check (QEC)	1) QEC and computerised movement analysis 2) QEC and experts assessment
Mcatemney and Corlett[26]	Rapid Upper Limb Assessment (RULA)	RULA and body parts discomfort score
Pehkonen et al.[27]	KitchenIntervention Work LoadAssessment (KILA)	KILA and experts assessment score
Legge and Burgess-limerick[28]	JobFit System Pre-Employment Functional Assessments (PEFAs)	PEFAs and statistical data on injuries

Universiti Kebangsaan Malaysia ergonomics lab agreed to be study samples (observers). They were briefed on how this method is used and the ergonomics risk factors present in the method.

Research procedure

At the beginning of the content validity test session, the observers together with the researchers assessed video recordings which served as training before they are tasked to assess the risks using the method being developed individually. After the observers completed the ergonomics risks assessment collectively, they were then shown video recordings of different work activities to be assessed individually. During this stage, discussions are allowed. This test method was also used in testing the Manual Handling Assessment Chart (MAC) method [29].

After the observers have completed the ergonomics risk assessment using the group discussion method, the researcher solicited feedbacks from the observers on the method used. Every observer who took part in the assessment of the SERA method was given the chance to openly give their opinion. The researchers took note of every feedback and opinion with the aim of improving the measurement method which is still at the early development stage. Based on the feedbacks, the researchers improvised the SERA method.

Research subjects

Respondents for this study consist of 88 oil palm plantation workers. As part of the selection criteria, respondents must at least worked in the plantation for 1 year and have no history of MSDs related problems.

Research procedure

A survey was conducted to get feedbacks from the respondents on body discomfort. It was carried out by three researchers with the assistance from an Occupational Health Doctor (OHD), the plantation's safety manager and plantation supervisor. A cross-sectional study was used in the survey. Previous studies showed that cross-sectional study is commonly used[30], where researchers focused on normal ergonomics problems occurrences in real time[31, 32, 33,34,35,36]. Respondents' body parts discomfort complaints were collected using NMQ which is specially designed to analyse MSDs[37]. During the NMQ development process, it was tested both for validity and reliability[37]. Findings showed that even though NMQ was not developed as a clinical tool to diagnose MSDs problems, it can be used to identify body musculoskeletal problems similar to periodic check-ups. NMQ was further tested for adaptation into various researches which need to assess pain involving MSDs[38,39]. Until today, NMQ is widely used in many work sectors in identifying MSDs[40]. Therefore, this study also uses NMQ as a tool to survey MSDs complaint. Through this survey, discomfort and painful body parts can be identified.

Video recordings of workers activities were also gathered as the workers go about their normal work routine. The purpose of the video recordings is to record the actual work activity of every worker so that the workers' working postures can be reviewed repeatedly when necessary while ergonomics risk assessment is conducted using SERA.

Statistical Analysis

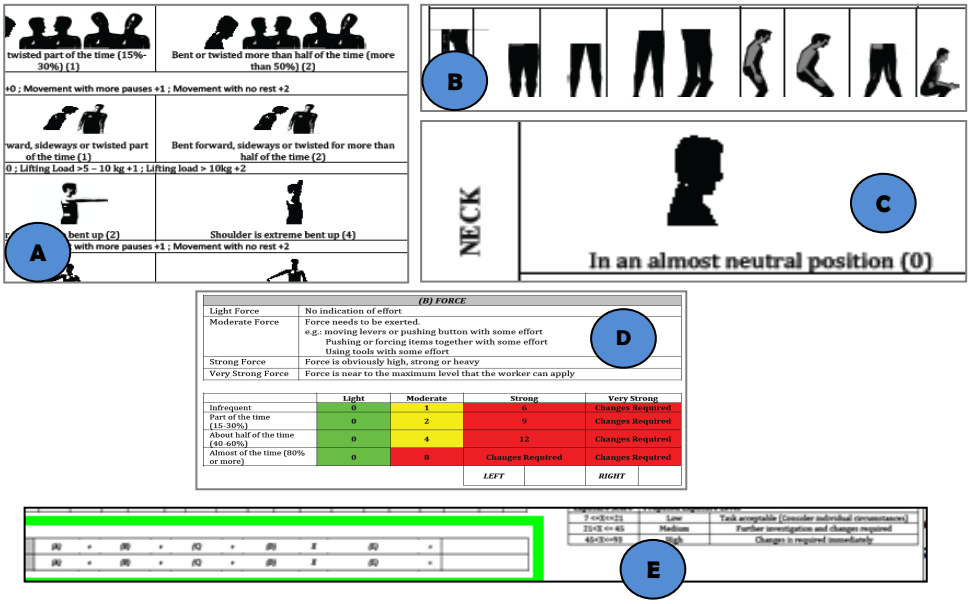
Criterion validity test for the SERA method and NMQ was carried out using the Chi-square test. Chi-square test is a test using data in category form to determine whether there are significant associations between two category variables in the population being studied even though it does not indicate the strength of the association. The Chi-square analysis was specifically used by Rahman et al.[23] in developing the WERA method.

RESULTS AND DISCUSSION

Content Validity Test

Opinions and constructive feedbacks were received from the six experts who agreed to be the samples in the content validity test. The SERA method was the focus during 2 hours of discussion. Issues related to method application, the need for training and other issues to ensure the method being developed can be used effectively were the main topics (Figure 1). Based on the discussion, the following issues were brought up.

A. Illustration to depict the body posture risk level must be improved as it creates confusion.
B. Illustration of the leg posture is difficult to understand.
C. The risk level of every posture is difficult to identify as it was placed parallel with the explanation of the posture.
D. The scoring system based on the colour of the traffic lights adapted from the ART[41] measurement method create confusion.
E. The placement of risk factor calculation and action level which is far apart, results in the observers being unable to understand the relationship/association of both tables.
F. The measurement method being developed consists of 2 sheets of paper. The experts suggested that it should be on just one sheet.



A: Some of the confusing posture illustrations **B**: Illustration of leg parts. **C:** scores placed parallel to the postureexplanation making it difficult to understand D: confusing colour codes. **E:** confusing final part placement

Figure 1 Someof the issues raised during the conduct of content validity test

Content validity test emphasised on the selection of ergonomics risk factors included in the measurement method. There were not many problems faced by the observers on each selected risk factor and the categorised risk levels as every risk factor was chosen after a systematic pilot study and comprehensive literature review. Hence the selection of ergonomics risk factors and its classifications are well accepted.

After the initial validity test, the researchers realised that the presentation of every selected risk factor is a bit confusing. After several discussions, improvements to the presentation were made (Figure 2 and 3).

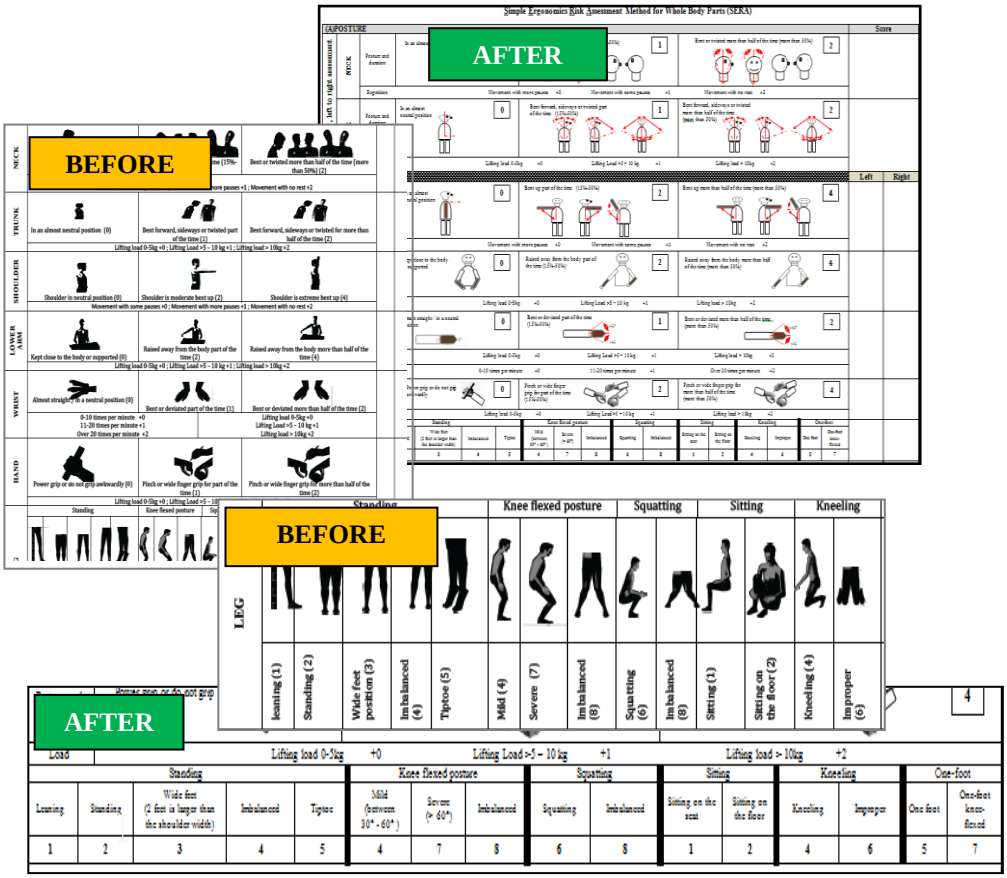


Figure 2 Diagram of SERA method before and after improvement made

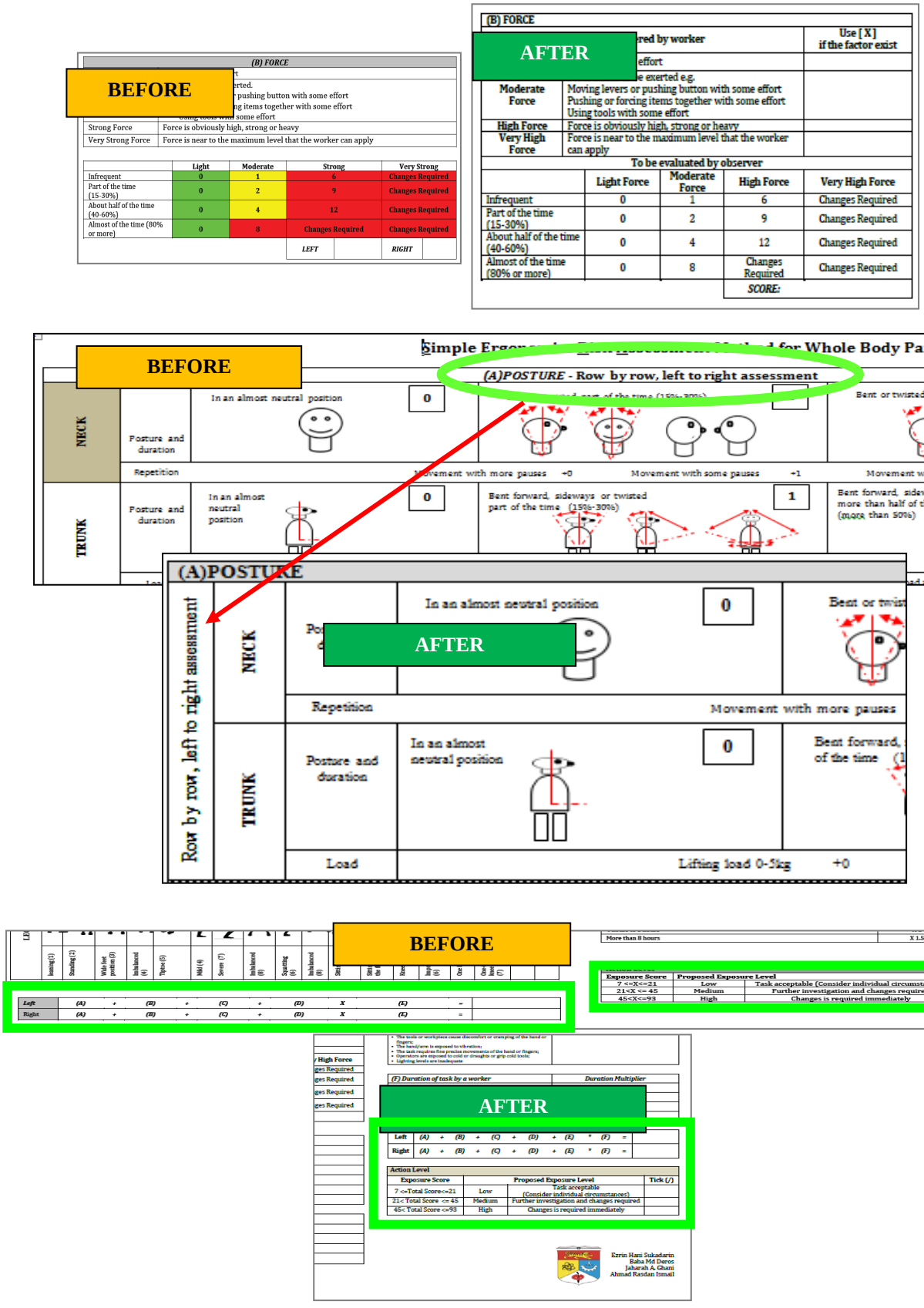


Figure3 Diagram of SERA method before and after improvement (continued)

However the scoring system of the SERA method received less attention from the observers. This also happened during the development of Manual Handling Assessment Chart (MAC)[29] method. According to Monningtonet al.[29], respondents in his study did not want to fiddle with MAC method scoring system fearing that it could jeopardise the overall system. A comprehensive literature study should be conducted before an ergonomics measurement method is developed. The development of the scoring system also requires extensive reading. If the scoring system is altered, the development of a measurement method has to be abandoned and re-started from scratch starting with the study of evidence from published epidemiology studies.

So, the researchers opined that it is adequate for the initial validity test; the selection of ergonomics risk factors and their presentation are assessed. Extensive studies should also be conducted for the scoring system. Therefore, the researchers conducted a criterion validity test for the scoring system. This was also suggested by Monnington et al.[29], if the scoring system is not validated, a lot of issues may arise in the future especially in its applicability of the method in measuring what it is supposed to measure and returning correct and valid outcomes.

Criterion Validity Test

A total of 88 respondents took part in this study. Table 2 shows the number of respondents according to their job scope in the oil palm plantation. The highest number of respondents (37.5%) is the FFB harvesters followed by loose fruits collectors (36.36%), frond arrangers (12.5%) and tractor drivers (13.63%).

Table 2 Number of respondents and their job scope (N=88)

No	Scope of work	n	%
1	Fresh fruit bunch (FFB) harvesters	33	37.5
2	Frond arrangers	11	12.5
3	Loose fruits collectors	32	36.36
4	Tractor drivers	12	13.63

Based on the number of respondents and the corresponding percentage, only the FFB harvesters and loose fruits collectors are taken into account in the criterion validity test. This is because a minimum sample of 30 is required for the hypotheses of this study; to be tested using inferential statistical analysis[42]. Table 3 shows the demography of theselected respondents in the criterion validity test.

Table 3 Demographic data of respondents for criterion validity test

	Age			Weight		Height (cm)	
	Mean	SD	Range	Mean	SD	Mean	SD
FFB harvesters (n = 33)	29.9	5.59	21-41	53.52	6.16	161.7	7.23
LFC (n=32)	27.9	6.78	18-45	51.6	6.23	157.9	10.7

FFB = Fresh fruit bunch ; LFC = Loose fruit collector

The FFB harvesters completed the NMQ questionnaire. Complaints regarding body parts discomfort (neck, hip, right shoulder, left shoulder, right arm, left arm, right wrist, left wrist, right leg and left leg) were recorded. The assessment requires the respondents to answer whether it is painful or not at the aforementioned body parts. Video recordings of every respondent were then analysed using the SERA method. Scores of low, medium and high from the SERA method are recorded and analysed using the Chi-square test. Findings from this test showed that there are significant relation between the scores of neck posture, hip, right shoulder, left shoulder, right wrist, left wrist and the right hand derived from SERA method assessment and pain complaints score at the aforementioned body parts from NMQ (Table 4).

Table 4 FFB harvesting activities (n=33)

	Painful	SERA Score			Chi-Square	Sig (*) p <0.05
		Low	Medium	High		
Neck	No	1	0	0	33.00	***0.000**
	Yes	0	8	24		
Hip	No	1	0	0	33.00	***0.000**
	Yes	0	3	29		
Right Shoulder	No	1	1	1	10.48	***0.005**
	Yes	0	20	10		
Left Shoulder	No	1	1	2	8.697	***0.013**
	Yes	0	20	9		
Right Arm	No	1	14	2	2.305	0.316
	Yes	2	14	0		
Left Arm	No	0	16	2	0.196	0.658
	Yes	0	14	1		
Right Wrist	No	10	6	0	9.512	***0.009**
	Yes	2	14	1		
Left Wrist	No	13	4	0	13.814	***0.001**
	Yes	2	13	1		
Right Arm	No	8	9	2	5.056	0.08
	Yes	1	10	3		
Left Arm	No	7	11	2	3.576	0.167
	Yes	1	9	3		
Right Leg	No	2	13	4	0.939	0.919
	Yes	1	8	4		
Left Leg	No	2	13	4	1.773	0.777
	Yes	1	7	5		

The loose fruits collectors also completed the NMQ. Complaints on body parts discomfort (neck, hip, right shoulder, left shoulder, right arm, left arm, right wrist, left wrist, right leg and left leg) were recorded.

The assessment requires the respondents to answer whether it is painful or not at the aforementioned body parts. Video recordings of every respondent were then analysed using the SERA method. Scores of low, medium and high from the SERA method are recorded and analysed using the Chi-square test.

Findings from this test showed that are significant relation between the scores of neck posture, hip, right shoulder, left shoulder, right wrist, left wrist and the right hand derived from SERA method assessment and pain complaints score at the aforementioned body parts from NMQ (Table 5).

In the development of the WERA[23] ergonomics measurement method, where the individual scores of workers from the construction industry, comprising 43 wall plasterers, 42 bricklayers and 44 cement masons, were statistically proven to have significant relations with the complaint scores at the hip and wrists. Findings from research by Rahman [23] is parallel with this study where both activities in the oil palm plantation have significant relations at the hip which is consistent with painful complaints reported in this study.

However, the WERA method does not differentiate the right and left side of the body during risk assessment, hence findings from this study which showed values for left and right body parts cannot be compared to findings of the WERA method.

Even though during the initial development stage of this SERA method, results showed that it is valid to be used as a tool to measure ergonomic risks at the workplace, there are body parts after being tested which do not have significant relations with MSDs complaints. Therefore, further tests need to be conducted as suggested by Hignett and Mcatemney[43] so that this ergonomics measurement method can be cross-referenced with other measurement methods, for example the WERA and QEC methods.

Table 5 Loose fruits collection activities (n=32)

	Pain	SERA Score			Chi-Square	Sig (*) p <0.05
		Low	Medium	High		
Neck	No	12	1	0	5.656	***0.017**
	Yes	10	9	0		
Hip	No	1	0	0	15.484	***0.000**
	Yes	1	27	3		
Right Shoulder	No	11	0	0	7.619	***0.022**
	Yes	20	9	1		
Left Shoulder	No	11	1	0	4.693	***0.030**
	Yes	11	9	0		
Right Arm	No	13	4	0	6.379	***0.041**
	Yes	5	9	1		
Left Arm	No	9	7	0	1.317	0.518
	Yes	7	8	1		
Right Wrist	No	9	7	0	2.136	0.344
	Yes	8	6	2		
Left Wrist	No	9	6	2	4.034	0.133
	Yes	5	10	0		
Right Hand	No	16	0	0	3.310	0.069
	Yes	13	3	0		
Left Hand	No	16	0	0	5.926	***0.015**
	Yes	11	5	0		
Right Leg	No	0	6	2	0.194	0.660
	Yes	0	16	8		
Left Leg	No	0	5	2	0.030	0.863
	Yes	0	17	8		

CONCLUSION

The SERA method was developed to assist researchers in quickly and thoroughly assess ergonomics risks at the workplace. Findings from the validity test showed that SERA was properly tested right from its content development stage. The content validity test helped the researchers to improve SERA presentation while the criterion validity test proved that the SERA method has significant relation with MSDs complaints for neck posture, hip, right shoulder, left shoulder, right wrist, left wrist and the right hand (FFB harvesting activities) and also has significant relation with MSDs complaints for neck posture, hip, right shoulder, left shoulder, right wrist, right arm and the left hand (loose fruits collection activities). However, there are body parts such as the legs which do not show any significant relation. Further tests should be conducted to explore the validity of the method being developed. Nevertheless, findings from both validity tests and the review by experts prove that this measurement method is valid to be used in the future.

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COMPETING INTERESTS

There is no conflict of interest.

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