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Original Article

Comparison of Ergonomic Risk Assessment Outputs from Rapid Entire Body Assessment and Quick Exposure Check in an Engine Oil Company

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ABSTRACT

Background: During the last decades, to assess the risk factors of work-related musculoskeletal disorders (WMSDs), enormous observational methods have been developed. Rapid Entire Body Assessment (REBA) and Quick Exposure Check (QEC) are two general methods in this field. This study aimed to compare ergonomic risk assessment outputs from QEC and REBA in terms of agreement in distribution of postural loading scores based on analysis of working postures.

Methods: This cross-sectional study was conducted in an engine oil company in which 40 jobs were studied. All jobs were observed by a trained occupational health practitioner. Job information was collected to ensure the completion of ergonomic risk assessment tools, including QEC, and REBA.

Results: The result revealed that there was a significant correlation between final scores (r=0.731) and the action levels (r =0.893) of two applied methods. Comparison between the action levels and final scores of two methods showed that there was no significant difference among working departments. Most of studied postures acquired low and moderate risk level in QEC assessment (low risk=20%, moderate risk=50% and High risk=30%) and in REBA assessment (low risk=15%, moderate risk=60% and high risk=25%).

Conclusion: There is a significant correlation between two methods. They have a strong correlation in identifying risky jobs, and determining the potential risk for incidence of WMSDs. Therefore, there is possibility for researchers to apply interchangeably both methods, for postural risk assessment in appropriate working environments.

Introduction

Work-related musculoskeletal disorders (WMSDs) are responsible for morbidity in many working populations and are known as an important occupational problem with increasing compensation and health costs, reduced productivity, and lower quality of life [1]. In recent years, many studies are conducted to provide basis for the risk assessment of the development of WMSDs [2]. WMSDs are characterized as multi factorial [3].

Quantifying mechanical loads on musculoskeletal system in occupational activities

have many methodological difficulties and limitations [4]. Therefore, alternative approaches based on simplified methods to file ergonomic exposures are required. Quantification of ergonomic exposures, based on comprehensive information on the frequency and duration of particular postures and movements, is now common. During the last decades, numerous ergonomic risk assessment methods have been developed for assessing exposure to risk factors for WMSDs, most of them assess the risk of the various regions of the body such as the back, neck, shoulder, arms and the wrists [3, 5-7].

The origins of ergonomic risk factors include the workstations, tools, equipments, work methods, work environment, worker personal characteristics, metabolic demands, physical stress, and emotional stress. Professionals from mechanical engineering, industrial engineering, occupational hygiene, occupational medicine, occupational therapy, kinesiology, psychology, and many other fields, provide unique insights into the relationship between worker/workplace and WMSDs. Understanding ergonomic risk factors are essential because there is indication that ergonomic risk factors are causally related to musculoskeletal disorders of the upper extremities and the low back [8].

There are abundant ergonomic risk assessment tools that attempt to evaluate the ergonomic risk of a task or job. For example, the Rapid Entire Body Assessment (REBA) and Quick Exposure Check (QEC) are more holistic ergonomic risk assessment tools that measure the ergonomic risks to the both upper and lower parts of the musculoskeletal system. Biomechanical assessments can be done for all the regions of the musculoskeletal system especially shoulder moments and moments about the low back. Evaluations of several ergonomic observational methods revealed that these methods had been developed based on special rationale, and as a result were applicable under various workplace conditions [5-7]. Each method has its own posture classification scheme, which is different from other methods and therefore may lead to assign different postural scores for a given posture, depending on particular methods used.

Since the time of introduction of QEC and REBA, studies showed their value for postural assessments of jobs in several occupational settings, including construction [9-10], supermarket workers [11], clothing manufacturing [12], assembly [13], rubber and sugar industry [14-15], firefighters and emergency medical technicians [16], sawmill [17] and hospital [18].

The present study aimed to compare ergonomic risk assessment observational methods, namely, QEC and REBA, in terms of agreement in distribution of postural loading scores based on analysis of working postures taken from an engine oil company.

Methods

This cross-sectional study was conducted in order to investigate correlation between risk assessment results of REBA and QEC in an engine oil company in which 40 jobs were studied. The company did not allow us to state its name and characteristic in details.

All jobs were observed by a trained occupational health practitioner. Job information was collected to ensure the completion of ergonomic risk assessment tools, including the QEC, and REBA. It should be noted that REBA and QEC are applied at task level of the jobs.

The REBA (Rapid Entire Body Assessment) is a posture-based analysis system responsive to musculoskeletal risks in various tasks, in particular for assessment of working postures that are present in health care sector and other service industries [19]. The classification of postures is derived from body part diagrams. The REBA is a method for estimating the risks of entire body WMSDs, gives a quick and logical assessment of the complete body postural risks to a worker, and is appropriate for evaluating tasks where postures are dynamic, static, or where gross changes in position take place. The design of REBA is very similar to that of RULA method [20] and special attention is devoted to the external load acting on trunk, neck, and legs and to the worker–load coupling using the upper limbs. Postures of individual body parts are observed and postural scores increase when postures diverge from the neutral position. Group A includes trunk, neck, and legs, while group B includes upper and lower arms and

wrists. Other items including the load handled, couplings with the load, and physical activity are specifically scored and then processed into a single combined risk score using a table provided. These scores are summed up to give one score for each observation, which can then be compared to tables stating risk at five levels, leading to the necessity of actions. Unlike OWAS [21] and RULA [20], REBA provides five action levels for estimating the risk level. These risk levels starting from 0 to 4 are corresponding to negligible, low, moderate, high and very high risk level respectively [20].

Quick Exposure Check (QEC) is an observational method that developed firstly by Li and Buckle in 1998 [22] and enhanced by David et al. in 2003 [23]. As other ergonomic risk assessment tools, QEC is applied to assess the level of exposure to ergonomic risks. QEC analysis produces scores to the back, shoulder/arm, wrist/hand, and neck. One of the unique features of QEC is that the observed worker should rate the weights handled, time spent on observed task, level of hand force, visual demands, application of vibrating tools, and difficulties to sustain with the work as well as the stressfulness of the work. The ratings are weighted into scores and added up to summary scores for different body parts and other items driving, vibration, work pace, and stress). In QEC to achieve an overall score, total scores obtained from four body parts are added and the product is divided by the maximum possible score, i.e., 176 for manual material handling tasks and 162 for others. Low scores (<40%) indicate satisfactory loading (low risk). For 41% to 50%, further investigation is needed and changes may be required (moderate risk). Timely investigation and changes are required soon for scores of 51% to 70% (high risk); and urgent investigation and changes are required for scores over 70% (very high risk). Finally, QEC provides 4 categories for estimating the risk level. These risk levels named from 1 to 4 are corresponding to low, moderate, high and very high risk level respectively [24-26].

In the study of oil company, every job is made up of a variety of tasks. The first aspect of the job evaluation was to break down each job into tasks. The job break down was consistent for each QEC and REBA analysis. There were 40 jobs with 123 tasks. From each studied job one task was selected for risk analysis by QEC and REBA methods based on 1) posture held for the greatest amount of the work cycle or 2) where highest loads occur. After the ergonomic data were completed, the ergonomic risk for each tool was quantified using REBA and the QEC. Using each method author's guide [19, 25], the tool output for each task computed and the final risk level identified. Accordingly, QEC and REBA outputs for each task were obtained respectively.

Statistical analysis was conducted using SPSS Version 13.0. Spearman correlation coefficient, Wilcoxon signed-rank test and Kruskal-Wallis test was done for comparing the risk assessment outputs of applied methods. *P* values <0.05 were considered statistically significant.

Results

Percentages of action levels of QEC and REBA for 40 studied jobs are presented in Table 1. According to this table, most of studied postures classified as low and moderate risk level in QEC assessment (low risk=20%, moderate risk=50% and High risk=30%) and also in REBA assessment (low risk=15%, moderate risk=60% and high risk=25%).

Table 1: Percentage of action levels of QEC and REBA outputs from 40 posture analyses

Action levels	QEC	REBA
Low risk	20	15
Moderate risk	50	60
High risk	30	25

The Wilcoxon signed-rank test showed that REBA and QEC action levels generally have no significant differences in 40 studied jobs. Further analysis using Wilcoxon signed-rank test in various working departments was done and no significant differences was found between REBA and QEC action levels among different working departments (Table 2). Table 3 shows the Kruskal-Wallis test results for REBA and QEC action levels between working departments. Similar to Wilcoxon signed-rank test results (Table 2), Kruskal-Wallis test showed no significant differences between REBA and QEC action levels among various working departments. Further analysis using

Kruskal-Wallis test was done on final scores of QEC and REBA among various working departments. As it may seen in Table 4, the test showed no significant differences between REBA and QEC final scores in different working departments. Correlation coefficients for final scores and action levels between QEC and REBA were $r=0.73$ and $r=0.89$, respectively (Figure 1).

Table 2: Wilcoxon signed-rank test results for REBA and QEC action levels (N=40) in working departments

Working departments	REBA Action Levels		QEC Action Levels		P value
	Mean	95% CI	Mean	95% CI	
Production	2.10	0.67, 3.53	2.10	0.67, 3.53	0.800
Packing	2.30	1.12, 3.48	2.37	1.17, 3.57	0.317
Labeling	2.00	0.41, 3.59	2.25	0.39, 4.11	0.317
Warehouse	1.66	0.54, 2.78	1.66	0.54, 2.78	0.800
Quality control	2.00	2.00, 2.00	1.00	1.00, 1.00	0.157
Engineering	2.00	2.00, 2.00	2.00	2.00, 2.00	0.800
Office	1.66	0.54, 2.78	1.66	0.54, 2.78	0.800

Table 3: Kruskal-Wallis test results for REBA and QEC action levels (N=40) in working departments

Working departments	REBA Action Levels		QEC Action Levels	
	Mean	95% CI	Mean	95% CI
Production	2.10	0.67, 3.53	2.10	0.67, 3.53
Packing	2.30	1.12, 3.48	2.37	1.17, 3.57
Labeling	2.00	0.41, 3.59	2.25	0.39, 4.11
Warehouse	1.66	0.54, 2.78	1.66	0.54, 2.78
Quality control	2.00	2.00, 2.00	1.00	1.00, 1.00
Engineering	2.00	2.00, 2.00	2.00	2.00, 2.00
Office	1.66	0.54, 2.78	1.66	0.54, 2.78
P value	P=0.562		P=0.151	

Table 4: Kruskal-Wallis test results for REBA and QEC final scores (N=40) in working departments

Working departments	REBA Final Scores		QEC Final Scores	
	Mean	95% CI	Mean	95% CI
Production	3.80	-0.90, 8.16	46.00	25.42, 58.46
Packing	6.00	1.88, 10.06	48.00	33.30, 57.46
Labeling	5.50	-0.14, 10.34	50.75	36.05, 60.21
Warehouse	5.33	1.25, 9.37	44.66	33.35, 52.39
Quality control	7.00	7.00, 8.96	32.50	31.13, 35.16
Engineering	5.00	5.00, 6.96	47.00	44.24, 50.37
Office	4.00	2.04, 6.96	36.33	17.00, 48.15
P value	P=0.147		P=0.673	

Discussion

The key finding of present study is the presence of significant correlation between two methods. QEC and REBA methods have a strong correlation in identifying risky jobs and determining the potential risk for incidence of WMSDs.

Due to absence of very high risk category and limited high risk category in outputs of REBA and QEC, the potential risk for incidence of WMSDs in most of studied working postures was low to moderate, therefore further investigation is needed and administrative and engineering controls may be required in some workstations. Recent studies that applied

REBA and QEC in their ergonomic risk assessment have reported, to some extent, similar outputs [9-18]. The absence of high-risk category in current study may be justified somewhat by smallness of analyzed postures (40 selected tasks). It should be noted that the aim of this study firstly was to compare ergonomic risk assessment outputs in two observational methods i.e. REBA and QEC.
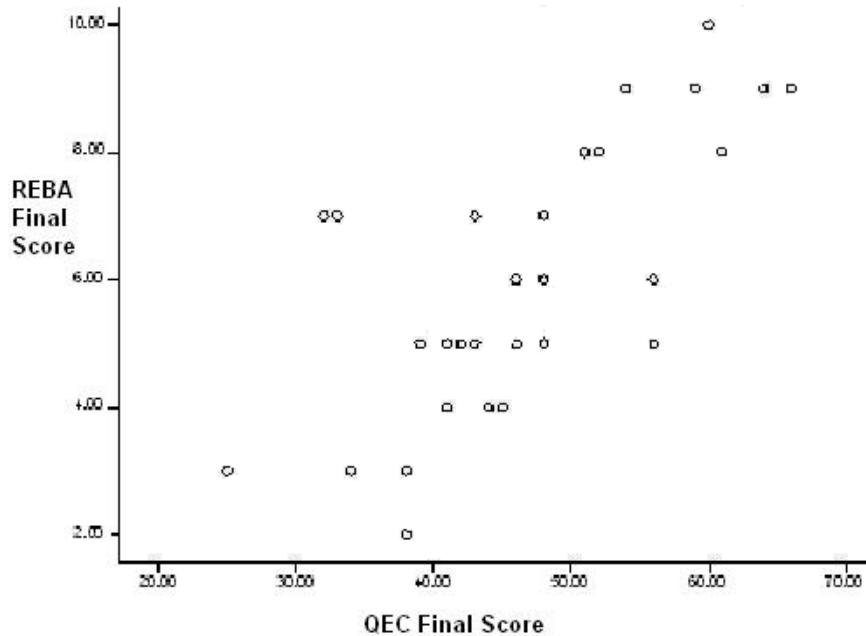

Figure 1: Scatter plot of QEC and REBA final scores

Up to now there is no research finding about comparison of risk assessment outputs from QEC and REBA. However, there are several researches about comparison between other ergonomics risk assessment observational methods [8, 11, 27-30]. In this study, we compared two different methods for the assessment of postural load in a population of an engine oil company workers. The applied methods of QEC and REBA were compared based on the results for 40 different working postures. The results showed that regardless of task type, QEC and REBA estimations for posture-related risk were similar. According to Figure 1, and computed correlation coefficients for QEC and REBA outputs including final scores (r=0.73) and action levels (r=0.89), there was a considerable agreement between the assessment outputs derived from two methods. In addition, according to Table 2, 3 and 4, Wilcoxon signed-rank and Kruskal-Wallis tests showed no significant differences between REBA and QEC assessment outputs in different working departments and confirm the association between the outputs of two applied methods. Therefore, there is possibility for researchers to apply interchangeably both used methods i.e. REBA and QEC, for postural risk assessment in appropriate working environments.

The most important limitation to the present study was that the relationships between each evaluation method and the injury data were unknown. Unfortunately, the injury data were not available from the plant.

Conclusion

Based on our findings, there is a significant correlation between two applied methods. They have a strong correlation in identifying risky jobs and determining the potential risk for incidence of WMSDs. Therefore, QEC and REBA methods are recommended for evaluation of work-related musculoskeletal disorders risk factors in similar industries.

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Conflict of interest statement

The authors declare that they have no conflicts of interest.

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