

Quick Exposure Checklist (QEC) for the Assessment of Workplace Risks for Work-Related Musculoskeletal Disorders (WMSDs)

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6.1 Background and Applications

The quick exposure checklist (QEC) quickly assesses the exposure to risks for work-related musculoskeletal disorders (WMSDs) (Li and Buckle, 1999a). QEC is based on the practitioners' needs and research on major WMSD risk factors (e.g., Bernard, 1997). About 150 practitioners have tested QEC and modified and validated it using both simulated and real tasks. QEC has a high level of sensitivity and usability and largely acceptable inter- and intraobserver reliability. Field studies

confirm that QEC is applicable for a wide range of tasks. With a short training period and some practice, assessment can normally be completed quickly for each task.

QEC gives an evaluation of a workplace and of equipment design, which facilitates redesign. QEC helps to prevent many kinds of WMSDs from developing and educates users about WMSD risks in their workplaces.

6.2 Procedure

QEC uses five steps:

6.2.1 Step 1: Self-Training

First-time QEC users must read the "QEC User Guide" (Appendix 6.1) to understand the terminology and assessment categories that are used in the checklist. Experienced users can skip step 1.

6.2.2 Step 2: Observer's Assessment Checklist

The QEC user (the observer) uses the "Observer's Assessment" checklist (Appendix 6.2) to conduct a risk assessment for a particular task. Most checklist assessment items are self-explanatory. New users can consult the "QEC User Guide" (Appendix 6.1). At least one complete work cycle is observed before making the assessment. If a job consists of a variety of tasks, each task can be assessed separately. Where a job cannot easily be broken down into tasks, the "worst" event within that job when a particular body part in question is most heavily loaded should be observed. The assessment can be carried out by direct observation or by using video footage (if the information about the "Worker's Assessment" can be obtained at another time; see step 3).

6.2.3 Step 3: Worker's Assessment Checklist

The worker being observed must complete the "Worker's Assessment" checklist (Appendix 6.3).

6.2.4 Step 4: Calculation of Exposure Scores

Use the "Table of Exposure Scores" (Appendix 6.4) to calculate the exposure scores for each task assessed as follows:

1. Circle all the letters corresponding to the answers from the "Observer's Assessment" and the "Worker's Assessment."
2. Mark the numbers at the crossing point of every pair of circled letters. For example, for the exposure to the back, number 8 should be selected as score 1, corresponding to the assessment items A2 and A3.
3. Calculate a total score for each body part.

Exposure score calculations can be done with the help of software (<http://www.geocities.com/qecuk>).

6.2.5 Step 5: Consideration of Actions

QEC quickly identifies the exposure levels for the back, shoulder/arm, wrist/hand, and the neck, and the method evaluates whether an ergonomic intervention can effectively reduce these exposure levels. Preliminary action levels for the QEC, based on QEC and RULA (McAtamney and Corlett, 1993) assessments of a variety of tasks, have been suggested (Brown and Li, 2003) as seen in Table 6.1.

The exposure level E in Table 6.1 is calculated as a percentage rate between the actual total exposure score X and the maximum possible total X_{max} . For manual handling tasks, $X_{maxMH} = 176$; for other tasks, $X_{max} = 162$.

$$E (\%) = X/X_{max} \times 100\%$$

TABLE 6.1 Preliminary Action Levels for the QEC

QEC Score (E) (percentage total)	Action	Equivalent RULA Score
≤40%	acceptable	1-2
41-50%	investigate further	3-4
51-70%	investigate further and change soon	5-6
>70%	investigate and change immediately	7+

6.3 Advantages

- Covers some major physical risk factors for WMSDs.
- Considers user needs and can be used by inexperienced users.
- Considers combination and interaction of multiple workplace risk factors.
- Provides good level of sensitivity and usability.
- Provides encouraging level of inter- and intraobserver reliability.
- Is easy to learn and quick to use.

6.4 Disadvantages

- Method focuses on physical workplace factors only.
- Hypothetical exposure scores with the suggested "action levels" need validating.
- Additional training and practice may be needed for novice users to improve assessment reliability.

6.5 Example of QEC Output

The following is an example of an observer assessing a manual handling task.

The task involves unloading boxes from a trolley onto a shelf. The operator's back is nearly straight, with infrequent movement during work. The boxes are sometimes placed at a height above shoulder level, with frequent adjustment for repositioning of the boxes, often using one hand. The hands/wrists were seen to bend and move between 11 and 20 times per minute, and the neck is occasionally seen to rotate to either side. The boxes weigh around 4 kg each, and the work lasts up to 6 hours per day. The visual demand for the task is considered low. The assessment results are shown in Figure 6.1.

The overall exposure is: $E = (106/176) \times 100\% = 60.2\%$. According to Table 6.1, the score indicates a need to "investigate further and change soon." The major concerns are the exposure to the shoulder/arm and the wrist regions because the operator has to handle the load at or above shoulder level. Possible solutions include providing the worker with a footstool to avoid raising the arms too high, using machinery (a forklift) for high-level loading, or introducing more frequent breaks to reduce the frequency of the repeated tasks.

After the workplace/task intervention, reassess the task using the same QEC approach as described in steps 2 to 5, and compare the pre- and postintervention results to see whether the exposures have been effectively reduced, preferably below an "acceptable" level.

6.6 Related Methods

The suggested "action levels" of the QEC system were based on equivalent RULA scores (McAtamney and Corlett, 1993). The tool was developed with a critical review and analysis of existing methods available at the time (Li and Buckle, 1999b), by adopting "user participation" approaches (e.g., using

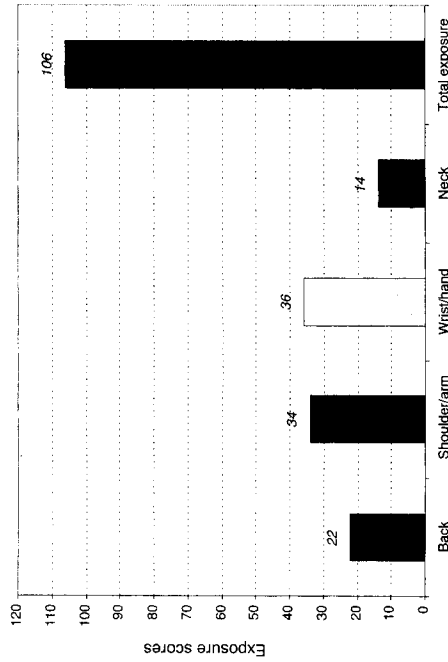


FIGURE 6.1 Assessment results of the example task.

questionnaires and focus groups and by asking the potential users — health and safety practitioners — to design an exposure tool for themselves [Li and Buckle, 1999a]), as well as by using a “think aloud” approach to understand the methods that health and safety practitioners adopt when undertaking a risk assessment in the workplace (Bainbridge and Sanderson, 1995).

6.7 Standards and Regulations

U.K. Management of Health and Safety at Work Regulations 1992:

Regulation 3 requires that “every employer shall make a suitable and sufficient assessment of the risks to the health and safety of his employees to which they are exposed whilst they are at work.... The purpose of the risk assessment is to help the employer or self-employed person to determine what measures should be taken to comply with the employer’s or self-employed person’s duties under the ‘relevant statutory provisions.’”

Regulation 12 mentions that “employees have a duty under Section 7 of the Health and Safety at Work etc. Act 1974 to co-operate with their employer to enable the employer to comply with statutory duties for health and safety.”

U.K. Manual Handling Operations Regulations 1992, Regulation 4(1)(b) requires that “each employer shall, where it is not reasonably practicable to avoid the need for his employees to undertake any manual handling operations at work which involve a risk of their being injured, make a suitable and sufficient assessment of all such manual handling operations to be undertaken by them.... The views of staff can be particularly valuable in identifying manual handling problems and practical solutions to them.”

6.8 Approximate Training and Application Times

The initial training (self-learning) time of the QEC for a new user is approximately 15 to 20 min, but some practice is suggested for novice users, with exercise assessments either on real tasks or on video-recorded tasks. It normally takes about 10 min to complete an assessment for each task.

6.8.1 Reliability and Validity

The construction validity of the QEC is reported in Li and Buckle (1999a). The tool is found to have a high sensitivity (the ability to identify a change in exposure before and after an ergonomic inter-

vention), a good intraobserver reliability, and a practically acceptable interobserver reliability (Li and Buckle, 1999a).

6.8.2 Tools Needed

QEC is a pen-and-paper-based exposure assessment tool. Calculation of exposure scores can be done with a computer program available at www.geocities.com/qecuc.

References

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- McAtamney, L. and Corlett, E.N. (1993), RULA: a survey method for the investigation of work-related upper limb disorders, *Appl. Ergonomics*, 24, 91–99.

Appendix 6.1 QEC User Guide

This exposure tool has been designed to assess the change in exposure to musculoskeletal risks before and after an ergonomic intervention. Before making the risk assessment, a preliminary observation of the job should be made for at least one work cycle. Record all information as listed at the top of the checklist in Appendix 6.2.

Exposure Assessment for the Back

Back Posture (A1 to A3)

The assessment for the back posture should be made at the moment when the back is most heavily loaded. For example, when lifting a box, the back may be considered under highest loading at the point when the person leans or reaches forward to pick up the load.

- The back can be regarded as “almost neutral” (Level A1) if the person is seen to work with his/her back flexion/extension, twisting, or side bending less than 20°, as shown in Figure A1.
- The back can be regarded as “moderately flexed or twisted” (Level A2) if the person is seen to work with his/her back flexion/extension, twisting, or side bending more than 20° but less than 60°, as shown in Figure A2.

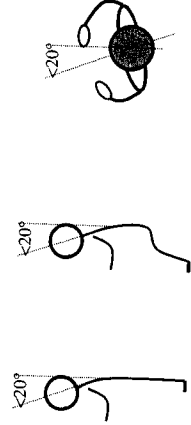


FIGURE A1 The back is “almost neutral.”

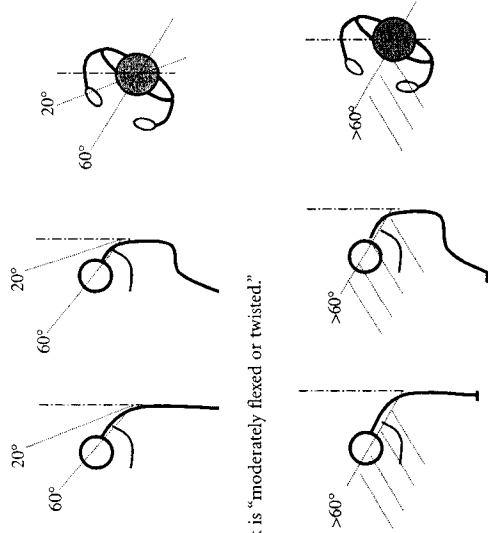


FIGURE A2 The back is "moderately flexed or twisted."

FIGURE A3 The back is "excessively flexed or twisted."

- The back can be regarded as "excessively flexed or twisted" (Level A3) if the person is seen to work with his/her back flexion or twisting more than 60° (or close to 90°), as shown in Figure A3.

Back Movement (B1 to B5)

- For manual material handling tasks, assess B1 to B3. This refers to how often the person needs to bend, rotate his/her back when performing the task. Several back movements may happen within one task cycle.
- For tasks other than manual handling, such as sedentary work or repetitive tasks performed in standing or seated position, ignore B1 to B3 and assess B4 and B5 only.

Exposure Assessment for the Shoulder/Arm

Shoulder/Arm Posture (C1 to C3)

Assessment should be made when the shoulder/arm is most heavily loaded during work, but not necessarily at the same time as the back is assessed. For example, the load on the shoulder may not be at the highest level when the operator bends down to pick up a box from the floor, but may become greater subsequently when the box is placed at a higher level.

Shoulder/Arm Movement (D1 to D3)

The movement of the shoulder/arm is regarded as

- "Infrequent" if there is no regular motion pattern
- "Frequent" if there is a regular motion pattern with some short pauses
- "Very frequent" if there is a regular continuous motion pattern during work

Exposure Assessment for the Wrist/Hand

Wrist/Hand Posture (E1 to E2)

This is assessed during the performance of the task at the point when the most awkward wrist posture is adopted, including wrist flexion/extension, side bending (ulnar/radial deviation), and rotation of the

wrist around the axis of the forearm. The wrist is regarded as "almost straight" (Level E1) if its movement is limited within a small angular range (e.g., <15°) of the neutral wrist posture (Figure E1). Otherwise, if an obvious wrist angle can be observed during the performance of the task, the wrist is considered to be "deviated or bent" (Figure E2).



FIGURE E1 The wrist is "almost straight."

FIGURE E2 The wrist is "deviated or bent."

Wrist/Hand Movement (F1 to F3)

This refers to the movement of the wrist/hand and forearm, excluding the movement of the fingers. One motion is counted every time when the same or similar motion pattern is repeated over a set period of time (e.g., 1 min).

Exposure Assessment for the Neck

The neck can be considered to be "excessively bent or twisted" if it is bent or twisted at an obvious angle (or more than 20°) relative to the torso.

Worker's Assessment of the Same Task

After the observer's assessment is made, ask the worker to answer the questions in the checklist in Appendix 6.3. Explain the meaning of the terms to him/her when necessary.

Calculation of the Total Exposure Scores

The total exposure scores can be obtained by combining the assessments from the observer (QEC checklist in Appendix 6.2, items A to G) and the worker (QEC checklist in Appendix 6.3, items a through g). Ensure that the correct combined scores have been determined before adding them into the total.

Additional Points

- For group work, ensure that a sufficiently representative number of individual workers are assessed.
- Workers whose daily pattern of work and job demands are variable should be observed more than once.

Appendix 6.2 Quick Exposure Checklist (QEC) for Work-Related Musculoskeletal Risks

<p>Wrist/Hand</p> <ul style="list-style-type: none"> • Is the task performed <ul style="list-style-type: none"> E1: With almost a straight wrist E2: With a deviated or bent wrist position? • Is the task performed with similar repeated motion patterns <ul style="list-style-type: none"> F1: 10 times per minute or less? F2: 11 to 20 times per minute? F3: More than 20 times per minute? <p>Neck</p> <ul style="list-style-type: none"> • When performing the task, is the head/neck bent or twisted excessively? <ul style="list-style-type: none"> G1: No G2: Yes, occasionally G3: Yes, continuously 	<p>Back</p> <ul style="list-style-type: none"> • When performing the task, is the back <ul style="list-style-type: none"> A1: Almost neutral? A2: Moderately flexed or twisted or side bent? A3: Excessively flexed or twisted or side bent? • For manual handling tasks only: Is the movement of the back- <ul style="list-style-type: none"> B1: Infrequent? (Around 3 times per minute or less) B2: Frequent? (Around 8 times per minute) B3: Very frequent? (Around 12 times per minute or more) • Other Tasks: Is the task performed in static postures most of the time? <ul style="list-style-type: none"> B4: No. B5: Yes (either seated or standing) <p>Shoulder/arm</p> <ul style="list-style-type: none"> • Is the task performed <ul style="list-style-type: none"> C1: At or below waist height? C2: At about chest height? C3: At or above shoulder height? • Is the arm movement repeated <ul style="list-style-type: none"> D1: Infrequently? (Some intermittent arm movement) D2: Frequently? (Regular arm movement with some pauses) D3: Very frequently? (almost continuous arm movement)
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Observer's Assessment
 Observer's name: _____
 Task: _____
 Date: _____
 Time: _____

Appendix 6.3 Worker's Assessment

Name: _____ Job title: _____ Date: _____

- What is the maximum weight handled in this task?
 - A1: Light (5 kg or less)
 - A2: Moderate (6 to 10 kg)
 - A3: Heavy (11 to 20 kg)
- How much time on average do you spend per day doing this task?
 - B1: Less than 2 hours
 - B2: 2 to 4 hours
 - B3: More than 4 hours
- When performing this task (single or double handed), what is the maximum force level exerted by one hand?
 - C1: Low (e.g., Less than 1 kg)
 - C2: Medium (e.g., 1 to 4 kg)
 - C3: High (e.g., More than 4 kg)
- Do you experience any vibration during work?
 - D1: Low (or no)
 - D2: Medium
 - D3: High
- Is the visual demand of this task.
 - E1: Low? (There is almost no need to view fine details)
 - E2: High? (There is a need to view some fine details)
- Do you have difficulty keeping up with this work?
 - F1: Never
 - F2: Sometimes
 - F3: Often
- How stressful do you find this work?
 - G1: Not at all
 - G2: Low
 - G3: Medium
 - G4: High

Appendix 6.4 Table of Exposure Scores

Exposure to the Back:

	Score 1				Score 2				Score 3				
	A1	A2	A3	B1	B2	B3	b1	b2	b3	b4	b5	Total score for the back = Sum of scores 1 to 5	
A1	2	4	6	2	4	6	2	4	6				
A2	4	6	8	4	6	8	4	6	8				
A3	6	8	10	6	8	10	6	8	10				
A4	8	10	12	8	10	12	8	10	12				
	Score 4												
B1	2	4	6	2	4	6	2	4					
B2	4	6	8	4	6	8	4	6					
B3	6	8	10	6	8	10	6	8					

Exposure to the Shoulder/Arm:

	Score 1			Score 2			Score 3			
	C1	C2	C3	D1	D2	D3	b1	b2	b3	
A1	2	4	6	2	4	6	2	4	6	
A2	4	6	8	4	6	8	4	6	8	
A3	6	8	10	6	8	10	6	8	10	
A4	8	10	12	8	10	12	8	10	12	
	Score 4									
B1	2	4	6	2	4	6	Total score for shoulder/arm = Sum of scores 1 to 5			
B2	4	6	8	4	6	8				
B3	6	8	10	6	8	10				

Exposure to the Wrist/Hand:

	Score 1			Score 2			Score 3			
	F1	F2	F3	E1	E2	E3	b1	b2	b3	
C1	2	4	6	2	4	6	2	4	6	
C2	4	6	8	4	6	8	4	6	8	
C3	6	8	10	6	8	10	6	8	10	
	Score 4									
B1	2	4	6	2	4	6	Total score for the wrist/hand = Sum of scores 1 to 5			
B2	4	6	8	4	6	8				
B3	6	8	10	6	8	10				

Exposure to the Neck:

	Score 1			Score 2			Total score for the neck = Scores 1 + 2		
	G1	G2	G3	e1	e2	e3			
b1	2	4	6	2	4	6			
b2	4	6	8	4	6	8			
b3	6	8	10	6	8	10			

Exposure scores: Back: _____ Shoulder/arm: _____ Wrist/hand: _____ Neck: _____