Comparisons of six observational methods for risk assessment of repetitive work - results from a consensus assessment

Katarina Kjellberg\textsuperscript{a,b}, Per Lindberg\textsuperscript{c}, Teresia Nyman\textsuperscript{a,b,d}, Peter Palm\textsuperscript{e}, Ida-Märta Rhen\textsuperscript{b}, Kristina Eliasson\textsuperscript{a,d}, Ruth Carlsson\textsuperscript{f}, Natalja Bälliu\textsuperscript{b}, Mikael Forsman\textsuperscript{a,b} \textsuperscript{a}\textsuperscript{a}Institute of Environmental Medicine, Karolinska Institutet, Stockholm, SWEDEN; \textsuperscript{b}Centre for Occupational and Environmental Medicine, Stockholm County Council, Stockholm, SWEDEN, \textsuperscript{c}Centre for Musculoskeletal Research, Faculty of health and occupational studies, University of Gävle, Gävle, SWEDEN, \textsuperscript{d}School of Technology and health, KTH Royal Institute of Technology, Stockholm, SWEDEN, \textsuperscript{e}Department of Medical Sciences, Occupational and Environmental Medicine, Uppsala University, and Akademiska sjukhuset, Uppsala, SWEDEN, \textsuperscript{f}Swedish Work Environment Authority, Stockholm, SWEDEN

\textbf{1. Introduction}

During last decades several risk assessment methods for physical ergonomics have been developed. In a literature review 30 observational methods for assessment of biomechanical exposures at work were evaluated (1). It was found that several methods are insufficiently tested in terms of validity and reliability. Comparisons between methods' resulting risk levels are rare. The Swedish Work Environment Authority has recently emphasized the demands on risk assessments of musculoskeletal disorders (2). Practitioners mostly use observational methods to assess biomechanical risks (1). Despite a recent study comparing eight methods evaluating risk factors associated with musculoskeletal disorders (3), there is a lack of knowledge and guidance on which methods are the most effective and valid.

This study is part of a larger on-going project, the OBS-project, with the overall purpose to evaluate six observational methods for assessment of biomechanical exposures of repetitive work in respect of validity, reliability and usability. A further purpose is to provide information on which of the methods are best suited for practitioners in risk assessment of repetitive work. The specific aim of this sub-study was to investigate the agreement between six observational methods for risk assessment of repetitive work by comparing the risk levels as assessed by a group of experts.

\textbf{2. Method}

An expert group of three experienced ergonomists made assessments of 10 video-recorded (2-6 minutes) work tasks (2 supermarket work tasks, meat cutting, meat packing, engine assembly, hairdressing, 2 cleaning tasks and 2 post sorting tasks) involving repetitive work with the upper extremities. Video sequences of two or three camera angles were synchronized and showed together. For each work task, the experts were given data of the work task length (between 2-7 hours per workday), pause- and rests-schedules, weights of handled goods, physical factors, as well as the employees' ratings of force exertion, discomfort, work demands and control.

The six observational methods were:
1. Occupational Repetitive Actions checklist (OCRA) (4)
2. Quick Exposure Checklist (QEC) (5)
3. Strain Index (SI) (6)
4. Assessment of Repetitive Tasks (ART) (7)
5. Hand Arm Risk-assessment Method (HARM) (8)
6. Model for assessment of repetitive work by the Swedish Work Environment Authority (SWEA) (2)

First each expert individually assessed the ten work tasks with the six methods. Then the group met and the experts observed the video recordings and assessed the work tasks together until a consensus agreement was reached. During a first round of three days, one method at a time was used for the assessment of respective work task. During a second round of additional three days, one work task at a time was assessed by all six methods, in order to secure that the assessment of e.g. cycle time and repetitiveness would be assessed in the same way. With only small adjustments, the results of the second round turned out to be similar to the first.
To be able to compare the methods with different types of indices, three risk levels; low, moderate and high risk, were used. SWEA, ART and HARM already have three risk levels, while OCRA, QEC and SI were categorised according to Chiasson et al (3). The agreements of the assessed risk levels between methods (in percent), and Cohen’s linearly weighted kappa (9) were calculated pairwise for methods assessing approximately the same body regions (table 1).

3. Results
The majority of the assessments emerged as moderate or high risk (figure 1). HARM identified the smallest proportion of the work tasks as high risk. The two methods assessing the hand/wrist; SI and QEC hand/wrist, were the most rigorous, classifying most work tasks as high risk.

![Distribution of risk levels for ten work tasks according to six assessment methods.](image)

Figure 1. Distribution of risk levels for ten work tasks according to six assessment methods. One method, QEC, provides separate scores for different body regions; therefore three indices are shown for QEC. *QEC general is calculated on the sum of the total scores for the back, shoulder/arm, wrist/hand and neck. **QEC upper extremity is calculated on the sum of the total scores for the shoulder/arm and wrist/hand.

When methods assessing the same body regions were compared pairwise, no pairs showed complete agreement (table 1). The best agreements were found between SWEA and QEC general, which both provide general assessments of risk, and between ART and OCRA, which assess the risk for the upper extremities.

4. Discussion
The methods identified risks of musculoskeletal disorders to a varied extent and no two methods were in perfect agreement; a finding similar to Chiasson et al’s (3). The methods vary with regard to included exposure variables, e.g. postures, force, dose (time), pauses, and also how these exposures are weighted in the calculation of the index scores, which probably explains the variation in resulting risk levels (1). Our results indicate which methods are the most rigorous, and which are the least, in classifying risky work tasks.
When using a method that classifies most work tasks into high risk, like SI, it may be difficult to use the assessments for prioritizing where to intervene and allocate resources. It may be that more than one method should be used for risk assessments (1, 3). In the continuation of this project, the influence of each variable included to calculate the risk level for each method will be studied, which could give guidance on which method suits which type of work task.

Table 1. Agreements of the assessed risk levels between methods (in percent) and Cohen’s linearly weighted kappa calculated pairwise for methods assessing the same body regions.

<table>
<thead>
<tr>
<th>Paired methods</th>
<th>Percentage of agreement</th>
<th>Weighted kappa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whole body/general</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SWEA - QEC general</td>
<td>80%</td>
<td>0.71</td>
</tr>
<tr>
<td>Upper extremity:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ART-HARM</td>
<td>50%</td>
<td>0.34</td>
</tr>
<tr>
<td>ART-OCRA</td>
<td>80%</td>
<td>0.74</td>
</tr>
<tr>
<td>ART- QEC upper extremity</td>
<td>60%</td>
<td>0.33</td>
</tr>
<tr>
<td>HARM-OCRA</td>
<td>50%</td>
<td>0.32</td>
</tr>
<tr>
<td>HARM-QEC upper extremity</td>
<td>20%</td>
<td>0.10</td>
</tr>
<tr>
<td>OCRA-QEC upper extremity</td>
<td>50%</td>
<td>0.17</td>
</tr>
<tr>
<td>Hand/wrist:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SI-QEC hand/wrist</td>
<td>60%</td>
<td>0.14</td>
</tr>
</tbody>
</table>

Keywords
Musculoskeletal disorders, risk assessment, observation, repetitive work

Acknowledgements
The study was funded by the Swedish Research Council for Health, Working Life and Welfare (FORTE).

References