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The inter-rater reliability of Strain Index and OCRA Checklist task assessments in cheese processing

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ABSTRACT

The purpose of this study was to characterize the inter-rater reliability of two physical exposure assessment methods of the upper extremity, the Strain Index (SI) and Occupational Repetitive Actions (OCRA) Checklist. These methods are commonly used in occupational health studies and by occupational health practitioners. Seven raters used the SI and OCRA Checklist to assess task-level physical exposures to the upper extremity of workers performing 21 cheese manufacturing tasks. Inter-rater reliability was characterized using a single-measure, agreement-based intraclass correlation coefficient (ICC). Inter-rater reliability of SI assessments was moderate to good (ICC = 0.59, 95% CI: 0.45–0.73), a similar finding to prior studies. Inter-rater reliability of OCRA Checklist assessments was excellent (ICC = 0.80, 95% CI: 0.70–0.89). Task complexity had a small, but non-significant, effect on inter-rater reliability SI and OCRA Checklist scores. Both the SI and OCRA Checklist assessments possess adequate inter-rater reliability for the purposes of occupational health research and practice. The OCRA Checklist inter-rater reliability scores were among the highest reported in the literature for semi-quantitative physical exposure assessment tools of the upper extremity. The OCRA Checklist however, required more training time and time to conduct the risk assessments compared to the SI.

1. Introduction

There are many semi-quantitative and observational physical risk assessment tools available to occupational health researchers and practitioners (Takala et al., 2010). The analyst should select a method based on the practicality, validity, reliability, and purpose of the risk assessment (David, 2005; Kilbom, 1994; Li and Buckle, 1999; Takala et al., 2010). Most semi-quantitative and observational tools are practical alternatives to more intensive (in terms of cost, labor, and time) biomechanical instrumentation (*i.e.*, direct measures) (David, 2005; Kilbom, 1994). The most comprehensive semi-quantitative assessments aim to precisely quantify worker exposure to physical musculoskeletal disorder (MSD) risk factors, such as the Strain Index (SI), the Occupational Repetitive Actions (OCRA) methods, or the National Institute for Occupational Safety and Health (NIOSH) Lifting Equation. However, a common limitation with most of these tools is that their underlying models assume that the job exposures under evaluation result from simple task completion (Garg and Kapellusch, 2011).

Simple tasks are typified by repetitive, single-exertion work activity performed with limited postural variability. Yet, most repetitive industrial tasks are complex, *i.e.*, they are comprised of subtasks (or work elements) which vary in their force, frequency and postural demands (Bao et al., 2009b). Several authors have reported the validity and reliability of risk assessments completed using semi-quantitative measures (Bonfiglioli et al., 2013; Garg et al., 2012; Occhipinti and Colombini, 2007; Spielholz et al., 2008; Stephens et al., 2006; Stevens et al., 2004; Waters et al., 1998), but these studies have not characterized how task-complexity affects assessment results. Additionally, the inter-rater reliability of OCRA Checklist assessments has not been characterized using standard statistical techniques. The purpose of the

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present study was to characterize the inter-rater reliability of SI and OCRA Checklist assessments of simple and complex cheese production tasks. The present study included these two exposure assessment tools because they comprehensively model physical exposure to upper extremity (UE) MSD risks differently, and occupational health professionals across the globe advocate for their use (Kapellusch et al., 2013; Occhipinti and Colombini, 2012). Additionally, the choice of the SI and OCRA Checklist for use in the present study was based on the type of work assessed, the research questions addressed and the author's experience with these assessment tools.

2. Material and methods

2.1. Study tasks

Physical exposure data for 21 cyclic work tasks were collected at a cheese production facility in Sardinia, Italy. These tasks represented all of the major stages of Pecorino Romano production, which yields a hard cheese in 25 and 35 kg wheels (Fig. 1). Researchers video-recorded the 21 tasks using handheld digital camcorders focused on the UE in the sagittal and frontal planes of the worker. Video recordings captured a minimum of five work cycles during normally scheduled work periods while workers were paid their usual wage. Task duration and break/recovery times were collected by direct observation and interviews with the facility management. The management and owners of the processing facility agreed to the study procedures and all participating employees provided informed consent. No personal (other than hand dominance) or identifying information was collected and no individual participant (employee) data was provided or available to the employer.

Tasks were predominantly externally-paced (by conveyor or demand from the next process) and represented a spectrum of repetitive UE activity, with work cycle times ranging from 6 to 106 s (mean = 41.5, SD = 31.2). The complexity of the cheese production tasks varied; six work cycles were comprised of a single subtask (mono-element), nine were comprised of two subtasks (dual-element), and six were comprised of three subtasks (tri-element).

2.2. Raters

Seven members of occupational health research groups from the University of Sassari in Italy and Colorado State University in the United States were recruited to assess the 21 cheese production tasks using the SI and OCRA Checklist separately. These ergonomics analysts (hereafter referred to as raters) included three university faculty performing occupational health research and four graduate students specializing in occupational ergonomics. Two of the raters were experienced SI users (using the tool for more than one year in manufacturing settings) and another researcher was an experienced OCRA Checklist rater. Two of the three participating faculty members were Board Certified Professional Ergonomists.

The majority of raters were novice users of the methods and all raters underwent appropriate training prior to task assessment. Strain Index training was administered separately from OCRA Checklist training. Training sessions included didactic instruction on the principles and procedures of each method, practice applying the methods to video segments of manufacturing tasks, and feedback from an experienced rater regarding method application. Training sessions continued until trainees achieved competency. Competency for each method was reached when trainees consistently (80% of time) assigned exposure ratings that were similar (within 20%) to the most experienced rater. The OCRA Checklist training required 10 h while the SI training required 4 h.

Once trained, raters were provided digital copies of the 21 video-recorded tasks and electronic SI and OCRA Checklist worksheets. The SI worksheet was based on Moore and Garg's (1995) original procedures. The OCRA Checklist worksheet was based on Colombini's et al. (2011) update of the method.

2.3. Exposure assessment

Raters assessed task exposures for the worker's left and right UEs, and tasks were assessed in alphabetic order according to task name. Task names had no inherent relationship to any of the physical exposure parameters, work cycle time or task complexity. Three raters completed the SI first and the other four raters completed the OCRA Checklist first. Each rater performed SI and OCRA Checklist assessments separately, and they did not communicate the results with one another. Additionally, after completing the initial 21 task assessments, raters did not have access to that data while reevaluating tasks with the second method. After completing each job assessment, raters were instructed to report time spent evaluating that job. This data was summarized for both the OCRA and SI after the study was finished.

Raters assigned scores to physical exposure parameters for the individual SI task variables *intensity of exertion*, *duration of exertion*, *efforts per minute*, *hand/wrist posture*, and *speed of work*; and for the individual OCRA Checklist task variables *force*, *frequency*, *awkward postures/movements*, and *additional factors*. To ensure consistency between force/exertion intensity estimates with each method, raters applied the Borg CR-10 scale (Borg, 1982) themselves rather than requesting (as the OCRA methods instruct) self-reported force estimates from workers. All estimates of forceful exertions were based on video observation of tasks and user motions/facial expressions as no direct measures were included in this study. Previous research does not indicate that expert-estimated force exposures are less accurate than workers' self-reported estimates (Bao et al., 2006; Spielholz et al., 2001). Data for SI *task duration per day* variable and the OCRA Checklist *lack of sufficient recovery* and *task duration* variables were provided to raters and all were scored the same.

The SI and OCRA Checklist risk classification cut points are depicted in Table 1. The SI risk index is normally classified along a three-level scale (Garg and Kapellusch, 2011), and the OCRA Checklist risk index is normally classified along a five-level scale. To facilitate comparison between the two tools, the cut points for the OCRA Checklist were condensed: level one (OCRA Checklist scores

Fig. 1. A worker tightens a mold around a 25 kg Pecorino Romano cheese wheel.