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Comparison of ergonomic risk assessments in a repetitive high-risk sawmill occupation: Saw-filer

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Abstract

Aims: The aims of this study are to: (1) compare the results of 5 ergonomic risk assessment methods calculated with quantified physical exposure information, (2) examine the effect of multiple definitions of the posture and exertion variable on the risk assessment methods, (3) describe the variability in risk assessment scores between workers, (4) examine the ability of risk assessment component scores to differentiate between facilities with significantly different levels of exposure, and (5) examine the association between risk output and recorded incidence rates.
Scope: Quantified physical exposure information collected from 15 saw-filers in four sawmill facilities was used to calculate the RULA, REBA, ACGIH TLV, Strain Index and OCRA procedures based on multiple posture and exertion variable definitions.
Results: Recorded incidence of upper extremity musculoskeletal injury in the saw-filer position ranged from 0.12 to 0.86 per person year worked. All risk assessment methodologies examined (with the exception of the ACGIH TLV calculated with %MVC) agreed a level of risk was associated with performance of the saw-filer job. Posture and exertion variable definition was observed to have a significant effect on the component scores and/or risk output of all methods assessed. Meaningful variability in risk assessment scores was observed between workers. Components of all assessments, with the exception of the ACGIH TLV, differentiated between facilities assessed. Average risk index scores of the SI and OCRA procedures were observed to increase as recorded incidence of injury increased; however statistical significance was not demonstrated.
Conclusions: Suggestive evidence exists that the components of the strain index and OCRA methods measuring posture and frequency were sensitive to actual differences between facilities and that the combined role of physical exposures in precipitation of musculoskeletal injury was accounted for. Posture and exertion variable definitions were observed to significantly affect the component scores and/or risk output of all methods.

Relevance to industry

An understanding of inter subject variability, the effect of variable definition selected, and the sensitivity of risk output to incidence of injury are necessary to correctly apply ergonomic risk assessments in industrial prevention efforts.

Keywords: Field study; Job analysis; Physical ergonomics; Forest products manufacturing

1. Introduction

In 2003, a review of Workers Compensation Board claims revealed the significant impact of musculoskeletal injuries (MSI) on the sawmill industry of Alberta, Canada (Jones and Kumar, 2004a). In the period reviewed, MSIs accounted for 32% of total claims cost (approximately $2,842,851) and 38% of total time loss (approximately 13,600 days lost) more than any other injury category. MSIs to the upper extremity accounted for a higher percentage of claims than any other body part. The saw-filer position was chosen for assessment in this study as a result of the high rate of upper extremity MSIs observed during the period reviewed. Rates of recordable upper extremity MSI incidents in the saw-filer ranged from 0.12

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to 0.86 per person year worked in the four facilities examined (Jones and Kumar, 2006). Given the impact of MSIs, industrial health and safety initiatives are now focused on MSI prevention. The established relationship between MSIs and the physical demands of the job has focused prevention efforts on the identification of problem exposures (US Department of Health and Human Services, 1997). Ergonomic risk assessment methods which consider multiple physical exposures in an integrated model of risk prediction are often used to direct industrial prevention initiatives. Currently, little agreement exists as to the physical exposures which should be considered in an assessment of risk and the relative role of those variables in the precipitation of MSI (Jones and Kumar, 2004b). For example, agreement between authors with regard to the relative role of the exertion variable has not been established (McAtamney and Corlett, 1993; Moore and Garg, 1995; Colombini, 1998; Grieco, 1998; Occhipinti, 1998; Hignett and McAtamney, 2000; University of Michigan, 2005). Further, agreement between authors as to the comparability and relationship between exertion assessed by quantified means (e.g. electromyography (EMG)) and psychophysical means (e.g. Borg CR-10 scale) has not been reached (McAtamney and Corlett, 1993; Moore and Garg, 1995; Colombini, 1998; Grieco, 1998; Occhipinti, 1998; Hignett and McAtamney, 2000; University of Michigan, 2005).

Few studies are available which compare the results of multiple assessment methods in the same worker population (Drinkaus et al., 2003; Bao et al., 2006). Studies which present and compare the risk assessment scores of multiple methods are needed to assess agreement between methods and gain an understanding of inter subject variability. Understanding inter subject variability is necessary to determine how many workers must be assessed to obtain representative risk assessment scores for that site or facility. One explanation for the paucity of literature examining the comparability of peer reviewed assessment methods is the limited ability of worksite evaluators to collect accurate and reliable exposure information by observation. Valid exposure measurement is a prerequisite to valid comparisons of risk assessment output. Recent studies have documented the large measurement error due to exposure information being collected by observation (Lowe, 2004). The use of tools capable of reliably collecting exposure information in the worksite (such as electrogoniometers and surface EMG) allows researchers to begin to assess the comparability of commonly used ergonomic risk assessment methods. Ergonomic risk assessment methods compared in this study were calculated based upon the quantified exposure information described in Jones and Kumar (2006).

Authors of 3 of the 5 methods examined here have proposed scales by which either percentage of maximum voluntary contraction (%MVC) or Borg ratings of exertion may be used to define the exertion component of the assessment. Collection of exertion information via EMG and psychophysical questionnaire allows the comparability of the measures of exertion to be evaluated. Work site evaluators measuring exposure by observation typically define postures by either the peak posture observed, average posture required to perform the primary task, or overall average posture. Use of electrogoniometers to collect posture information allows the comparability of posture variable definitions to be examined. No studies of the effect of either exertion or posture variable definition on ergonomic risk assessments could be located. The definitions of the exposure variables examined in this study have been chosen to reflect those available to worksite evaluators assessing industrial exposures via observation.

The aims of this study are to: (1) compare the results of 5 ergonomic risk assessment methods calculated with quantified physical exposure information, (2) examine the effect of multiple definitions of the posture and exertion variable on the risk assessment methodologies, (3) describe the variability in risk assessment scores observed within assessments between workers, (4) examine the ability of risk assessment component, scores to differentiate between facilities with significantly different levels of exposure, and (5) examine the association between risk output and recorded incidence rates.

The risk assessment methods compared in this study are the: Rapid Upper Limb Assessment (RULA), Rapid Entire Body Assessment (REBA), the quantified version of the American Conference of Governmental Industrial Hygienists Threshold Limit Value for mono-task hand work (ACGIH TLV), the Strain Index (SI), and the concise exposure index (OCRA) (McAtamney and Corlett, 1993; Moore and Garg, 1995; Colombini, 1998; Grieco, 1998; Occhipinti, 1998; Hignett and McAtamney, 2000; University of Michigan, 2005). Each method's risk output has been broken into two scores; risk index and risk level. Risk index refers to the risk assessments' raw score output before that score is grouped and interpreted. Risk level refers to the groupings of risk index scores which are interpreted into action levels, etc. by the original authors.

2. Methods

2.1. Task description

The function of the saw-filer job to maintain the condition of round saws, ban saws and chipper knives necessary to enable the sawmill facility to operate efficiently. The primary task of the saw-filer is to tension and correct imperfections in round saws. Both the correction of imperfections and tensioning of the round saw require the saw-filer strike the body of the round saw with a 1.13 kg hammer. Time required to correct imperfections and tension the round saw varies by round saw. The physical exposures used to calculate the risk assessment methods described in this study were measured during the primary task only; hammering of round saws (imperfection