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Accuracy of spine cumulative loading using self-reported duration and frequency information during non-occupational tasks

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Abstract

Cumulative spinal loads have been shown to be independent risk factors for LBP reporting in industry. However, collection and analysis of this type of data is expensive and time-consuming, particularly if non-repetitive tasks, such as those that are common in non-occupational activities in the home, are assessed. Cumulative load assessment costs may be reduced if self-report methods could be utilized, in lieu of traditional video-based approaches. The purpose of the present study was to investigate the accuracy of two types of self-report methods for estimating cumulative low back loads using frequency and duration information gathered during simulated non-occupational tasks. Eight male and 8 female subjects participated in this study in one of two reporting conditions (LOG: reporting done after each task; RECALL: reporting done after end of 2 h session). Mean relative errors between cumulative loads determined from subject reports of frequency and duration and from direct exposure measures from video were under 10% in general and were greater for the RECALL than the LOG condition for all cumulative loads. The difference in relative error between conditions was only significant for cumulative flexion/extension moment. Estimated and actual cumulative moments were highly correlated in the LOG condition ($r = 0.989$, $p < 0.001$), and only moderately so in the RECALL condition ($r = 0.403$, $p < 0.001$). The LOG approach showed promise as an inexpensive and accurate method for documenting frequency and duration information for the estimation of cumulative low back loads.

Relevance to industry: Cost effective documentation of cumulative loads in non-occupational tasks may help to explain why low back pain continues to persist in occupational settings despite the modification of peak work exposures that regularly occur in industry. Self-report methods may provide a less time and equipment intensive approach for documenting cumulative exposure and be useful for assessments of industrial tasks with varied time demands that pose significant challenges using traditional video-based approaches.

Keywords: Self-report; Non-occupational tasks; Cumulative loading; Low back; Biomechanical model

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1. Introduction

Cumulative spine loading has been identified as a significant risk factor for reporting low back pain (Kumar, 1990; Norman et al., 1998; Kerr et al., 2001). Since the collection and processing of cumulative load data is expensive and time-consuming, recent research efforts have aimed to reduce these costs. Callaghan et al. (2001) compared five commonly used video-based cumulative loading quantification methods to a gold standard method involving rectangular integration of the resultant biomechanical outputs at 30 frames/s. They determined that reducing the number of frames of data processed from 30 to 5 frames/s did not induce significant error into the cumulative loading estimates of symmetrical tasks. Andrews and Callaghan (2003) found that further reducing the sampling rate to 3 frames/s did not induce greater than 5% error (relative to 60 frames/s) in the majority of cases. Assessment of cumulative loads requires long periods of subject observation, in order to obtain a representative sample of their activities throughout a shift or day. Keown et al. (2002) determined that three trials of a repetitive lifting task gave a sufficient representation of the cumulative loads sustained due to this task throughout the shift/day. Recent work by Agnew et al. (2003) also showed that a magnetic tracking device can be used to obtain positional data in real time, and resulted in cumulative load estimates that did not significantly differ from estimates obtained through traditional, labor intensive video-based methods.

Although the above authors have succeeded in reducing the time requirements of collecting and processing cumulative load data, financial costs and time demands remain considerable. Self-report measures enable researchers to collect a large amount of data at a relatively low cost (Winkel and Westgaard, 1992). Although some studies have suggested that both the validity and reliability of self-report measures in general may be low (Burdorf and Laan, 1991; Van der Beek et al., 1994), others have demonstrated that some self-report measures can be reasonably accurate depending on the type and detail of information that is requested (Wiktorin et al., 1993; Andrews et al., 1996; Viikari-Juntura et al., 1996; Pope et al., 1998; Mortimer et al., 1999). In particular, acceptable accuracy of self-reported duration and frequency of working postures and manual material handling has been reported (Wiktorin et al., 1993; Pope et al., 1998; Mortimer et al., 1999). Some studies also acknowledge the usefulness of a logbook approach for gathering demands information (Burdorf and Laan, 1991; Knibbe and Friele, 1999; Akesson et al., 2001), particularly in settings where more direct assessments are challenged by limited space and privacy issues, such as those seen in nursing (Knibbe and Friele, 1999). However, assessments of the accuracy of self-report logs in many settings have not been performed, and their ability to enable the estimation of internal exposure measures, such as cumulative spine compression and shear forces, from self-reported duration and frequency information, remains unknown to date.

Structured interviews conducted by trained medical personnel were used by Seidler et al. (2001, 2003) to document workplace task characteristics. In the interviews, participants were asked to describe what lifting tasks they had performed and details including the weight and frequency of the lifts. Task descriptions were subsequently used to estimate cumulative spinal loads with a simplified regression-based biomechanical approach. Although justified by the additional diagnostic information they required, the interview-based method presented by Seidler et al. (2001, 2003) requires considerable involvement from trained personnel and results in costs that are not possible for many evaluations. The accuracy of the frequency information and resultant cumulative spinal loads using the interview approach was also not provided.

Accurate self-report methods that do not require an interview could potentially help to reduce the cost of cumulative load assessments by downloading the responsibility of tracking the duration and frequency of performed tasks to the worker. This would be particularly helpful for very non-repetitive tasks such as those performed by people in their homes. Results of the few studies to date that have documented cumulative loads associated with non-occupational tasks (Lauder