Ergonomics– rok 2007, ročník 50

Číslo 9

S. L. Fischer; W. J. Albert; A. J. McClellan; J. P. Callaghan. Methodological considerations for the calculation of cumulative compression exposure of the lumbar spine: A sensitivity analysis on joint model and time standardization approaches. S. 1365–1376.

Cumulative lumbar spine loading has attracted much attention as a factor associated with the development of low back pain. While evidence supports cumulative loading to be a plausible mechanism in explaining several workplace injuries, research establishing a threshold limit value (TLV) for cumulative spine loading has been challenging. The lack of a TLV or even a trend towards harmful cumulative load values may suggest that methodological considerations are greatly influencing the results. This paper examines the impact of different joint models (single muscle equivalent, an electromyography-based third order polynomial, a modified version of the polynomial and a hybrid approach) to determine cumulative spine compression, as well as the importance of time standardization in the calculation of a daily cumulative loading dose. Findings demonstrated that the polynomial predicted cumulative compression values were 43-53% higher than those with all other models tested and the single muscle equivalent predicted loads 18% higher than loads predicted using a modified polynomial. Profound differences between modelling approaches suggest that caution should be taken when selecting a muscle model to determine cumulative spine compressive loading. Time standardized cumulative compression values were found to be 28.3% greater than non-standardized estimates, illustrating the importance of selecting a standard time frame in the calculation of cumulative spine compression.

- **Keywords:** Biomechanical modelling; Cumulative loading; Low back pain; Unplanned rest

G. S. Faber; I. Kingma; J. H. Van Dieën. The effects of ergonomic interventions on low back moments are attenuated by changes in lifting behaviour. S. 1377–1391.

This study investigated the effects of ergonomic interventions involving a reduction of the mass (from 16 to 11 and 6 kg) and an increase in the initial lifting height (from pallet height to 90 cm above the ground) of building blocks in a mock-up of an industrial depalletizing task, investigating lifting behaviour as well as low back moments (calculated using a 3-D linked segment model). Nine experienced construction workers participated in the experiment, in which they removed building blocks from a pallet in the way they normally did during their work. Most of the changes in lifting behaviour that were found

would attenuate the effect of the investigated interventions on low back moments. When block mass was reduced from 16 to 6 kg, subjects chose to lift the building block from a 10 (SD 10) cm greater distance from the front edge of the pallet and with a 100 (SD 66) degrees/s^2 higher trunk angular acceleration. When initial lifting height was increased, subjects chose to shift the building blocks less before actually lifting them, resulting in a 10.7 (SD 10) cm increase in horizontal distance of the building blocks relative to the body at the instant of peak net total moment. Despite these changes in lifting behaviour, the investigated ergonomic interventions still reduced the net total low back moment (by 4.9 (SD 2.0) Nm/kg when block mass was reduced and 53.6 (SD 41.0) Nm when initial lifting height was increased).

- **Keywords:** Manual materials handling; Lifting; Mock-up; Low back moment; Lifting behaviour; Ergonomic intervention

R. W. McGorry; J.-H. Lin. Power grip strength as a function of tool handle orientation and location. S. 1392–1403.

Thirty male volunteers participated in a study evaluating the effect of workspace envelope (work height and reach distance) and handle orientation on grip force capacity. Maximum voluntary power grip exertions were recorded using instrumented tool handles under three conditions: a pistol grip tool handle oriented horizontally and vertically and a right angle tool handle oriented horizontally. Significant main effects of handle height and reach location on normalized grip force capacity were observed with the horizontally oriented pistol grip and right angle handles, whereas only an interaction effect was observed with the vertically oriented pistol grip handle. Comparison of results to scores produced with a job assessment tool (RULA) is included as an appendix. The proposed methodology can provide information useful to job, workstation or tool design directed toward best accommodating the physical capacities of workers performing hand tool tasks.

- **Keywords:** Maximum voluntary exertion; Hand tool; Workspace envelope; RULA

Y.-K. Kong; B. D. Lowe; S.-J. Lee; E. F. Krieg. Evaluation of handle design characteristics in a maximum screwdriving torque task. S. 1404–1418.

The purpose of this study was to evaluate the effects of screwdriver handle shape, surface material and workpiece orientation on torque performance, finger force distribution and muscle activity in a maximum screwdriving torque task. Twelve male subjects performed maximum screw-tightening exertions using screwdriver handles with three longitudinal shapes (circular, hexagonal and triangular), four lateral shapes (cylindrical, double frustum, cone and reversed double frustum) and two surfaces (rubber and plastic). The average finger force contributions to the total hand force were 28.1%, 39.3%, 26.5% and 6.2%, in order from index to little fingers; the average phalangeal segment force contributions were 47.3%, 14.0%, 20.5% and 18.1% for distal, middle, proximal and metacarpal phalanges, respectively. The plastic surface handles were associated with 15% less torque output (4.86 Nm) than the rubber coated handles (5.73 Nm). In general, the vertical workpiece orientation was associated with higher torque output (5.9 Nm) than the horizontal orientation (4.69 Nm). Analysis of handle shapes indicates that screwdrivers designed with a circular or hexagonal cross-sectional shape result in greater torque outputs (5.49 Nm, 5.57 Nm), with less total finger force (95 N, 105 N). In terms of lateral shape, reversed double frustum handles were associated with less torque output (5.23 Nm) than the double frustum (5.44 Nm) and cone (5.37 Nm) handles. Screwdriver handles designed with combinations of circular or hexagonal cross-sectional shapes with double frustum and cone lateral shapes were optimal in this study.

- **Keywords:** Screwdriver handle design; Handle shape; Handle surface; Maximum torque exertion

K. Kotani; L. H. Barrero; D. L. Lee; J. T. Dennerlein. Effect of horizontal position of the computer keyboard on upper extremity posture and muscular load during computer work. S. 1419–1432.

The distance of the keyboard from the edge of a work surface has been associated with hand and arm pain; however, the variation in postural and muscular effects with the horizontal position have not been explicitly explored in previous studies. It was hypothesized that the wrist approaches more of a neutral posture as the keyboard distance from the edge of table increases. In a laboratory setting, 20 adults completed computer tasks using four workstation configurations: with the keyboard at the edge of the work surface (NEAR), 8 cm from the edge and 15 cm from the edge, the latter condition also with a pad that raised the work surface proximal to the keyboard (FWP). Electrogoniometers and an electromagnetic motion analysis system measured wrist and upper arm postures and surface electromyography measured muscle activity of two forearm and two shoulder muscles. Wrist ulnar deviation decreased by 50% (4°) as the keyboard position moved away from the user. Without a pad, wrist extension increased by 20% (4°) as the keyboard moved away but when the pad was added, wrist extension did not differ from that in the NEAR configuration. Median values of wrist extensor muscle activity decreased by 4% maximum voluntary contraction for the farthest position with a pad (FWP). The upper arm followed suit: flexion increased while abduction and internal rotation decreased as the keyboard was positioned further away from the edge of the table. In order to achieve neutral postures of the upper extremity, the keyboard position in the horizontal plane has an important role and needs to be considered within the context of workstation designs and interventions.

- **Keywords:** Muscular load; Upper extremity; Posture; Computer; Musculoskeletal discomfort

A. C. Macquet; P. Fleurance. Naturalistic decision-making in expert badminton players. S. 1433–1450.

This paper reports on a study of naturalistic decision-making in expert badminton players. These decisions are frequently taken under time-pressured conditions, yet normally lead to successful performance. Two male badminton teams participated in this study. Self-confrontation interviews were used to collect data. Inductive data analysis revealed three types of intentions during a rally: to maintain the rally; to take the advantage; and to finish the point. It also revealed eight types of decision taken in this situation: to ensure an action; to observe the opponent's response to an action; to realize a limited choice; to influence the opponent's decision; to put pressure on an opponent; to surprise the opponent; to reproduce an efficient action; and to play wide. A frequent decision was to put pressure on the opponent. Different information and knowledge was linked to specific decisions. The results are discussed in relation to research that has considered naturalistic decision-making.

- **Keywords:** Naturalistic decision-making; Expert performance; Badminton

A. L. Schutz; M. A. Counte; S. Meurer. Assessment of patient safety research from an organizational ergonomics and structural perspective. S. 1451–1484.

The aim of this study is to review patient safety improvement initiatives within a conceptual framework that builds upon principles of organizational ergonomics and emphasizes structural factors that influence patient safety. The literature review included 131 English language published studies of patient safety improvement strategies extracted using Medline, Ovid Healthstar, PubMed and CINAHL searches. Keywords for

the search included: 'patient safety'; 'medical errors'; 'adverse event'; 'iatrogenic'; and truncated options for 'improve'. The multilevel, hierarchical framework offered in this paper integrates quality management principles and organizational ergonomics theory and organizes patient safety initiatives according to sociotechnical system elements within three structural levels: health policies and associated health care organizations; health care delivery organizations; and health care microsystems. Utilizing the conceptual framework, this review of patient safety improvement initiatives highlights the need for consideration of the impact of all improvement proposals on each structural component within health care systems. The review also supports the need for patient safety research to evolve from exploratory, 1-D reporting to multi-level, integrated research.

- **Keywords:** Patient safety; Organizational ergonomics; Health policy; Health management

L. Smith; H. J. Jeppesen; H. Bøggild. Internal locus of control and choice in health service shift workers. S. 1485–1502.

This study examined the relationship between shift work-specific locus of control (SH-LOC), active choice of work schedule and health outcomes, personal initiatives and coping behaviours in 1611 Danish Health Service shift workers. The 20-item SH-LOC scale was administered as part of a battery of measures. Multivariate analysis of covariance (controlling for age, workplace experience and weekly work hours) tested for differential responses to shift working and coping strategies. Interactive effects of internality and type of work rota were examined. Higher internality was linked to better tolerance to shift work. This did not appear to be a result of greater personal action in higher internals. The importance of control as a potential moderating factor to shift work exposure and the possible use of this measure in the process of shift worker monitoring is highlighted.

- **Keywords:** Shift work; Internal locus of control; Choice; Health; Coping

A. Pretorius; P. J. Cilliers. Development of a mental workload index: A systems approach. S. 1503–1515.

The objective of this study is to develop a method for determining the mental workload imposed on train control officers that is objective and quantifiable and can stand up to the tests of validity and reliability. This technical note reports on the methodology used in the development process, as well as the assessment of the criteria considered for the mental workload index (MWLI). The MWLI aims at solving an existing operational shortcoming and could be used as a tool for predicting the mental workload imposed on an operator at a particular train control centre. The method could be applied to manage and improve operational safety in the rail transport environment. A participative approach was followed in the development process. A work group comprising expert users of the system was involved in identifying task factors and assigning weights for task and moderating factors. The newly developed MWLI consists of three task factors and 11 moderating factors, each with a different weight in terms of its contribution to overall mental workload. The work group performed several iterations to reach final consensus and acceptance of the factors and their respective contributions to the MWLI. The criteria and development processes are discussed and the final index with the task and moderating factors is presented.

- **Keywords:** Mental workload; Mental workload assessment; Workload; Stress