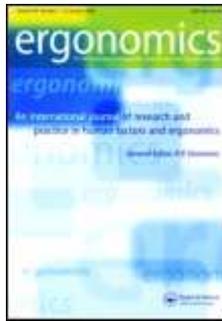


Ergonomics– rok 2007, ročník 50

Číslo 5



Mary Ann Holbein-Jenny; Kyle McDermott; Cory Shaw; Jason Demchak. Validity of functional stability limits as a measure of balance in adults aged 23-73 years. S. 631–646.

Functional stability limits (FSLs) are the percentage of the base of support that individuals are willing to extend their centre of pressure. The objective of this study was to provide construct validation of FSLs as a measure of balance by comparing FSLs across ages and with clinical balance measures. A total of 52 participants volunteered. FSLs significantly decreased with age ($p < 0.004$). Correlations between FSLs and age ($-0.56 < R < -0.73$), multi-directional reach test ($0.35 < R < 0.75$) and anteroposterior and mediolateral centre of pressure excursions during static stance ($-0.29 < R < -0.72$) were generally moderate to good. Cronbach's alpha (0.75) indicated that these measures were internally consistent, i.e. measuring similar aspects of the balance construct. FSLs appear to be valid indicators of balance ability. They may be used in posture prediction models to determine when a step is required when reaching or lifting objects and in biomechanical models as a means of incorporating stability constraints.

- **Keywords:** Falls; Centre of pressure; Base of support; Functional reach test; Posture; Postural sway

Per Jonsson; Peter W. Johnson; Mats Hagberg. Accuracy and feasibility of using an electrogoniometer for measuring simple thumb movements. S. 647 – 659.

The aim of this study was to determine the accuracy and feasibility of using an electrogoniometer (Model SG 110; Biometrics, Gwent, UK) for measuring simple thumb movements. Thumb disorders have been associated with the use of hand held devices such as mobile phones and these devices have become an integral part of modern life. In 15 young subjects, the measurements of eight flexion/extension (Flex/Ext) and adduction/abduction (Ad/Ab) thumb positions were compared between a thumb-mounted electrogoniometer and manual goniometer (which was taken as the benchmark). Group mean electrogoniometric measurement errors were below 4° and 5° for Ad/Ab and Flex/Ext measurements, respectively. During mobile phone use, the electrogoniometers measured differences in maximal joint angle postures, which appeared to be related to differences in mobile phone size. High movement velocities may increase the risk of musculoskeletal injury and the results indicated that Ad/Ab movements were twice the speed of Flex/Ext movements during mobile phone use. Electrogoniometers have utility for studying thumb movements during mobile phone use and may be used to evaluate other thumb-based input devices.

- **Keywords:** Thumb; Goniometry; Posture; Repetitive motion disorders; Upper extremity

Jae Kun Shim; Junfeng Huang; Alexander W. Hooke; Mark L. Latsh; Vladimir M. Zatsiorsky. Multi-digit maximum voluntary torque production on a circular object. S. 660-675.

Individual digit-tip forces and moments during torque production on a mechanically fixed circular object were studied. During the experiments, subjects positioned each digit on a 6-dimensional force/moment sensor attached to a circular handle and produced a maximum voluntary torque on the handle. The torque direction and the orientation of the torque axis were varied. From this study, it is concluded that: (1) the maximum torque in the closing (clockwise) direction was larger than in the opening (counter clockwise) direction; (2) the thumb and little finger had the largest and the smallest share of both total normal force and total moment, respectively; (3) the sharing of total moment between individual digits was not affected by the orientation of the torque axis or by the torque direction, while the sharing of total normal force between the individual digit varied with torque direction; (4) the normal force safety margins were largest and smallest in the thumb and little finger, respectively.

- **Keywords:** Finger; Torque; Circular object; Safety margin

T. Jones; S. Kumar. Assessment of physical demands and comparison of multiple exposure definitions in a repetitive sawmill job: board edger operator. S. 676-693.

The primary objectives of the study were to 1) describe the physical exposures in a sawmill job with a high incidence of upper extremity musculoskeletal injuries in terms of multiple measures of posture, exertion and frequency (with varying definitions) and 2) to examine the comparability of those definitions. Surface electromyography and electrogoniometry were used to quantify the muscle demands and joint motions. Fourteen board edger operators from two sawmill facilities participated. All exposure assessments, with the exception of surface EMG measurements, were performed on the production lines. EMG measurements were performed within the facility in a location removed from the production line. The measurements showed that, on average, ranges of motions of 59, 102 and 84 degrees respectively in the planes of wrist radial/ulnar deviation, flexion/extension and pronation/supination were required to perform the job. Significant differences ($p < .001$) were observed between ranges of motion defined by peak postures and those due to peak postures required to perform the primary task only. Performance of the primary task required an average of 32% of maximum voluntary contraction from the forearm muscles assessed. Repetitions per day ranged, on average, from 2,015 to 9,365. Incidence of reported upper extremity musculoskeletal injuries in the two facilities assessed was found to be higher with the greater total exposure. However, examination of the trend with a standardized measure of injury incidence was not possible.

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

Kjell Ivar Øvergård; Knut Inge Fostervold; Hans Vanhauwaert Bjelland; Thomas Hoff. Knobology in use: an experimental evaluation of ergonomics recommendations. S. 694-705.

The scientific basis for ergonomics recommendations for controls has usually not been related to active goal-directed use. The present experiment tests how different knob sizes and torques affect operator performance. The task employed is to control a pointer by the use of a control knob, and is as such an experimentally defined goal-directed task

relevant to machine systems in general. Duration of use, error associated with use (overshooting of the goal area) and movement reproduction were used as performance measures. Significant differences between knob sizes were found for movement reproduction. High torques led to less overshooting as opposed to low torques. The results from duration of use showed a tendency that the differences between knob sizes were reduced from the first iteration to the second iteration. The present results indicate that the ergonomically recommended ranges of knob sizes might differently affect operator performance.

- **Keywords:** Ergonomics recommendations; Performance; Interface design; Controls

C. M. Sommerich; R. Ward; K. Sikdar; J. Payne; L. Herman. A survey of high school students with ubiquitous access to tablet PCs. S. 706–727.

This paper presents findings of a study of high school students participating in a tablet PC (TPC) programme. Primary areas of interest were students' experiences with and attitudes about the TPCs, physical discomfort associated with use of TPCs and temporal and task-driven patterns of TPC use. Data were collected via questionnaire and computer use-monitoring software. Results showed students' attitudes were generally quite positive towards the TPCs, although they did not tend to think TPCs had improved their grades, few disagreed that TPCs were a distraction in class, and visual and musculoskeletal discomfort was prevalent. Understanding how to use the TPC and recognizing its organizational capacity were associated with several positive attitudes towards the TPC, including making school more enjoyable. Children's exposure to computers will only increase, so study of the many dimensions of their impact is critical in order to understand what is effective, constructive and healthful for children.

- **Keywords:** Mobile computers; Education; Information technology

Christa Devroey; Ilse Jonkers; An de Becker; Gerlinde Lenaerts; Arthur Spaepen. Evaluation of the effect of backpack load and position during standing and walking using biomechanical, physiological and subjective measures. S. 728–742.

Recommendations on backpack loading advice restricting the load to 10% of body weight and carrying the load high on the spine. The effects of increasing load (0%-5%-10%-15% of body weight) and changing the placement of the load on the spine, thoracic vs. lumbar placement, during standing and gait were analysed in 20 college-aged students by studying physiological, biomechanical and subjective data. Significant changes were: (1) increased thorax flexion; (2) reduced activity of M. erector spinae vs. increased activation of abdominals; (3) increased heart rate and Borg scores for the heaviest loads. A trend towards increased spinal flexion, reduced pelvic anteversion and rectus abdominis muscle activity was observed for the lumbar placement. The subjective scores indicate a preference for the lumbar placement. These findings suggest that carrying loads of 10% of body weight and above should be avoided, since these loads induce significant changes in electromyography, kinematics and subjective scores. Conclusions on the benefits of the thoracic placement for backpack loads could not be drawn based on the parameter set studied.

- **Keywords:** Backpack; Load; Musculoskeletal adaptation; Subjective score

Stephen H. M. Brown; Jim R. Potvin. The effect of reducing the number of EMG channel inputs on loading and stiffness estimates from an EMG-driven model of the spine. S. 743–751.

Electromyography (EMG)-driven models of the spine routinely require between ten and 14 EMG channels to estimate joint load and stiffness variables. This study was designed to determine the sensitivity of common EMG-driven model outputs to the removal of individual EMG channels, and to test two adapted models driven from eight channels. A total of 11 male participants performed a variety of static exertions designed to resist either an applied trunk flexion or right side trunk lateral bend moment. In this study, 14 channels of EMG were recorded and used to drive a biomechanical model of the spine to predict L4-L5 joint load and stiffness values. The model was subsequently re-run after the removal of individual pairs of bilateral EMG channels, and again with eight-channel models in which the rectus abdominus, latissimus dorsi and multifidus EMG-channels were eliminated. Results showed that the eight-channel model provided estimates for the majority of output variables that did not differ substantially from the 14-channel model, except in instances in which muscle force output was ramped to resist flexion moments. Estimates of the output variables were, in general, improved when multifidus fascicles were re-added to the model and driven from the lumbar erector spinae EMG sites.

- **Keywords:** Sensitivity analysis; Model reduction; Biomechanical model; Compression; Shear; EMG

D. Leyk; U. Rohde; O. Erley; W. Gorges; D. Essfeld; T. C. Erren; C. Piekarski. Maximal manual stretcher carriage: performance and recovery of male and female ambulance workers. S. 752–762.

The effects of a maximal duration stretcher carriage on heart rate (HR), lactate concentration, hand steadiness and hand-grip strength were studied up to 72 h post-exercise in 17 male and 15 female military ambulance personnel. Using both hands for transport, the participants walked on a treadmill ergometer at a speed of 4.5 km/h. Force measurements at the handlebars yielded mean loads of 245 N (25 kg) on each side. Each step on the treadmill induced additional force oscillations with peak forces up to 470 N corresponding to 130% (women) and 98% (men) of maximal voluntary contraction (MVC). In the males the maximal transport time was about twice the time in women (mean \pm SD: 184 \pm 51 s vs. 98 \pm 34 s). These differences had no significant effect on HR and lactate values. The same applies to hand steadiness, which showed only a transient deterioration immediately after exercise. In contrast to these parameters, substantial differences were seen in hand-grip strength recovery. Immediately after exercise, maximal hand-grip strength decreased by 150 N (25% MVC) in the males vs. 50 N (14%) in the females. Irrespective of gender, individuals with larger hand-grip strength and longer carriage durations (range 120 s-280 s) showed the slowest strength recoveries (up to 72 h) as compared to 1 h of recovery in participants with short transport durations (range 27 s-120 s). These findings suggest that the increasing number of eccentric strains during uninterrupted stretcher carriage induces cumulative muscle damages that may require some days for complete recovery.

- **Keywords:** Load carriage; Eccentric strain; Manual coordination; Hand-grip strength; Fatigue

Yuval Bitan; Joachim Meyer. Self-initiated and respondent actions in a simulated control task. S. 763–788.

Operators often need to combine self-initiated and respondent actions. Two experiments dealt with the relative importance of these two types of actions as a function of the predictability of the system and the available information. Participants monitored three stations with different frequencies at which interventions were required. They were aided by warning cues, indicating the need for interventions. The frequencies of inspections of the stations, the response to the warning system and the overall performance were assessed for warning systems with different diagnostic properties. Participants adapted their responses to the relative frequency of required interventions and the reliance on

and compliance to the warning system depended on the warning characteristics. The results support the notion that events, such as warning signals, have a complex role in the ongoing activity of the operator and are integrated into the set of information from external and internal sources that guide the operators' actions.

- **Keywords:** Alarm systems; Self-initiating and responding; Controlled task