

## **Ergonomics– rok 2015, ročník 58**

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**Courtenay Harris, Leon Straker, Clare Pollock, Anne Smith. *Children, computer exposure and musculoskeletal outcomes: the development of pathway models for school and home computer-related musculoskeletal outcomes*. Pages. 1611-1623.**

Children's computer use is rapidly growing, together with reports of related musculoskeletal outcomes. Models and theories of adult-related risk factors demonstrate multivariate risk factors associated with computer use. Children's use of computers is different from adult's computer use at work. This study developed and tested a child-specific model demonstrating multivariate relationships between musculoskeletal outcomes, computer exposure and child factors. Using pathway modelling, factors such as gender, age, television exposure, computer anxiety, sustained attention (flow), socio-economic status and somatic complaints (headache and stomach pain) were found to have effects on children's reports of musculoskeletal symptoms. The potential for children's computer exposure to follow a dose-response relationship was also evident. Developing a child-related model can assist in understanding risk factors for children's computer use and support the development of recommendations to encourage children to use this valuable resource in educational, recreational and communication environments in a safe and productive manner. **Practitioner Summary:** Computer use is an important part of children's school and home life. Application of this developed model, that encapsulates related risk factors, enables practitioners, researchers, teachers and parents to develop strategies that assist young people to use information technology for school, home and leisure in a safe and productive manner.

- **Keywords:** pathway models, computers, musculoskeletal disorders, children, home, school

**Sylvie Leclercq, Aude Cuny-Guerrier, Clarisse Gaudez, Agnès Aublet-Cuvelier. *Similarities between work related musculoskeletal disorders and slips, trips and falls*. Pages. 1624-1636.**

Most occupational risks manifest themselves through movements performed at work, for example musculoskeletal disorders, slips, trips and falls. Research focusing on such risks often differentiates diseases from accidents. All these risks prove to be diffuse,

widespread, emergent and devoid of an external harmful hazard, when analysed through their common vector, i.e. through the movements manifesting them. These characteristics have a strong impact on risk perception and on approaches necessary to ensure sustainable prevention. A participative search for local solutions to preventing these risks, integrating shared risk representation and several analysis levels, would seem helpful. A balance between defended and resilience-based conceptions of health and safety should be established. Research should also be extended to enhance in-depth understanding of controls impacting worker movements when performing a task, while safeguarding health and safety. **Practitioner Summary:** Progress in the field of musculoskeletal disorders would contribute to preventing occupational accidents with movement disturbances. This paper highlights the significance of both establishing a balance between health and safety-defended conception and system resilience enhancement, and better understanding the individual controls involved in performing a task, while safeguarding health and safety.

- **Keywords:** occupational injuries, slips trips and falls, musculoskeletal disorders, movement, sustainable prevention

**Alan C. Cudlip, Jack P. Callaghan, Clark R. Dickerson. *Effects of sitting and standing on upper extremity physical exposures in materials handling tasks.* Pages 1637-1646.**

Sitting or standing work configurations modulate musculoskeletal risk. Most existing investigations of these configurations have either studied them separately or lacked focus on the upper extremity, particularly during manual materials handling (MMH) tasks. To address this gap, upper extremity loading in 20 male and 20 females were assessed in 4 MMH tasks in sitting and standing. Differences in electromyographic (EMG) activity, local joint moments and body discomfort between configurations were examined. Interactions between task and sit/stand configuration resulted in increases of up to 500% in joint moments, 94% in EMG activity and 880% in discomfort when tasks were completed while sitting ( $p < 0.01$ ). Future MMH task designers should consider placing workers in standing postures when feasible to reduce upper extremity loading, but workers should not remain in either configuration for extended periods of time as the negative effects of both workspace geometries can instigate future musculoskeletal disorders. **Practitioner Summary:** Sitting and standing modify occupational musculoskeletal risk. We examined how performing identical tasks while sitting or standing altered upper extremity and low back loading. In general, sitting increased muscle activity and discomfort, while standing increased local joint moments. The benefits of standing outweighed those of sitting across the range of tasks.

- **Keywords:** work design, physical demands, manual materials handling, sit-stand, shoulder

**Olivier Thuong, Michael J. Griffin. *The vibration discomfort of standing people: evaluation of multi-axis vibration.* Pages 1647-1659.**

Few studies have investigated discomfort caused by multi-axis vibration and none has explored methods of predicting the discomfort of standing people from simultaneous fore-and-aft, lateral and vertical vibration of a floor. Using the method of magnitude estimation, 16 subjects estimated their discomfort caused by dual-axis and tri-axial motions (octave-bands centred on either 1 or 4 Hz with various magnitudes in the fore-and-aft, lateral and vertical directions) and the discomfort caused by single-axis motions. The method of predicting discomfort assumed in current standards (square-root of the sums of squares of the three components weighted according to their individual contributions to discomfort) provided reasonable predictions of the discomfort caused by multi-axis vibration. Improved predictions can be obtained for specific stimuli, but no single simple method will provide accurate predictions for all stimuli because the rate of

growth of discomfort with increasing magnitude of vibration depends on the frequency and direction of vibration. **Practitioner Summary:** Useful estimates of the vibration discomfort of standing people can be obtained from the root-sums-of squares of the floor acceleration in each of the three directions (fore-and-aft, lateral and vertical) if the three components are frequency-weighted according to the dependence of discomfort on the frequency of vibration in each axis.

- **Keywords:** whole-body vibration, standing, multi-axis vibration, discomfort

**Jose-Antonio Diego-Mas, Rocio Poveda-Bautista, Diana-Carolina Garzon-Leal. *Influences on the use of observational methods by practitioners when identifying risk factors in physical work.* Pages 1660-1670.**

Most observational methods for musculoskeletal disorder risk assessment have been developed by researchers to be applied in specific situations, and practitioners could find difficulties in their use in real-work conditions. The main objective of this study was to identify the factors which have an influence on how useful the observational techniques are perceived to be by practitioners and to what extent these factors influence their perception. A survey was conducted on practitioners regarding the problems normally encountered when implementing these methods, as well as the perceived overall utility of these techniques. The results show that practitioners place particular importance on the support the methods provide in making decisions regarding changes in work systems and how applicable they are to different types of jobs. The results of this study can serve as guide to researchers for the development of new assessment techniques that are more useful and applicable in real-work situations. **Practitioner Summary:** A survey about the use of ergonomics assessment methods for identifying risk factors in physical work was conducted among practitioners. The reasons to find a method more or less useful were analysed. The support the methods provide in making decisions regarding changes in work systems and how applicable they are to different types of jobs were found to be the main reasons.

- **Keywords:** ergonomics, practitioners, observational methods, risk assessment

**Sean R. Notley, Gregory E. Peoples, Nigel A.S. Taylor. *The utility of heart rate and minute ventilation as predictors of whole-body metabolic rate during occupational simulations involving load carriage.* Pages 1671-1681.**

The utility of cardiac and ventilatory predictors of metabolic rate derived under temperate and heated laboratory conditions was evaluated during three fire-fighting simulations (70-mm hose drag, Hazmat recovery, bushfire hose drag;  $N = 16$  per simulation). The limits of agreement for cardiac (temperate:  $-0.54$  to  $1.77$ ; heated:  $-1.39$  to  $0.80$   $\text{l min}^{-1}$ ) and ventilatory surrogates (temperate:  $-0.19$  to  $1.27$ ; heated:  $-0.26$  to  $1.16$   $\text{l min}^{-1}$ ) revealed an over-estimation of oxygen consumption that exceeded the acceptable limits required by occupational physiologists ( $N = 25$ ;  $\pm 0.24$   $\text{l min}^{-1}$ ). Although ventilatory predictions offered superior precision during low-intensity work ( $P < 0.05$ ), a cardiac prediction was superior during more demanding work ( $P < 0.05$ ). Deriving those equations under heated conditions failed to improve precision, with the exception of the cardiac surrogate during low-intensity work ( $P < 0.05$ ). These observations imply that individualised prediction curves are necessary for valid estimations of metabolic demand in the field. **Practitioner Summary:** Cardiac and ventilatory surrogates are often used to approximate the metabolic demands of work. In this study, however, such predictions demonstrated unsatisfactory agreement with simultaneously measured values across three fire-fighting simulations. Therefore, individually calibrated equations appear necessary to obtain the level of predictive precision required by occupational physiologists.

- **Keywords:** fire fighting, heart rate, metabolic demand, oxygen consumption, ventilation

**Stuart McGill, David Frost, Thomas Lam, Tim Finlay, Kevin Darby, Jordan Cannon. Can fitness and movement quality prevent back injury in elite task force police officers? A 5-year longitudinal study. Pages 1682-1689.**

Elite police work has bursts of intense physically demanding work requiring high levels of fitness, or capacity, and movement competency; which are assumed to increase one's injury resilience. The purpose of this study was to follow members of an elite police force ( $N = 53$ ) to test whether back injuries ( $N = 14$ ) could be predicted from measures of fitness and movement quality. Measures of torso endurance, relative and absolute strength, hip ROM and movement quality using the Functional Movement Screen™ and other dynamic movement tests were obtained from every officer at baseline. When variables were grouped and considered holistically, rather than individually, back injury could be predicted. Seven variables best predicted those who would suffer a back injury (64% sensitivity and 95% specificity for an overall concordance of 87%). Overall, the ability to predict back injury was not high, suggesting that there is more complexity to this relationship than is explained with the variables tested here. **Practitioner Summary:** Members of elite police forces have exposure to intense physically demanding work. Increased levels of fitness and movement competency have been assumed to increase injury resilience. However, complexity in the interactions between exposure, movement competency, training, fitness and injury may occlude the true relationship between these variables.

- **Keywords:** predicting injury, back pain, fitness, strength, range of motion, assessment, FMS

**Peter Le, Jaejin Hwang, Sarah Grawe, Jing Li, Alison Snyder, Christina Lee, William S. Marras. Biomechanical patterns of text-message distraction. Pages 1690-1700.**

The objective of this study was to identify biomechanical measures that can distinguish texting distraction in a laboratory-simulated driving environment. The goal would be to use this information to provide an intervention for risky driving behaviour. Sixteen subjects participated in this study. Three independent variables were tested: task (texting, visual targeting, weighted and non-weighted movements), task direction (front and side) and task distance (close and far). Dependent variables consisted of biomechanical moments, head displacement and the length of time to complete each task. Results revealed that the time to complete each task was higher for texting compared to other tasks. Peak moments during texting were only distinguishable from visual targeting. Peak head displacement and cumulative biomechanical exposure measures indicated that texting can be distinguished from other tasks. Therefore, it may be useful to take into account both temporal and biomechanical measures when considering warning systems to detect texting distraction. **Practitioner Summary:** Text-message distraction while driving has been associated with an alarming and growing number of injuries and fatalities. This study identified potential biomechanical indications that could potentially serve as a warning with the intent of reducing crashes from texting.

- **Keywords:** texting, text-messaging, cell phone distraction, mobile phone distraction

**Gregory E. P. Pearcey, Scott N. MacKinnon, Duane C. Button. Simulated motion negatively affects motor task but not neuromuscular performance. Pages 1701-1713.**

The effects of long duration simulated motion on motor task and neuromuscular performance along with time frames required to recover from these effects are relatively unknown. This study aimed to determine (1) how simulated motion affects motor task and neuromuscular performance over one hour of motion and (2) the time course of recovery from any decrements. The dependent variables that were measured included: reaction time; visuomotor accuracy tracking; maximal voluntary contractions; voluntary activation; evoked contractile properties and biceps brachii electromyography of the elbow flexors. Reaction times and error rates of the visuomotor accuracy tracking task were compromised in motion, but maximal force, voluntary activation, evoked contractile properties and rmsEMG responses of the biceps brachii were unaffected by motion. It is concluded that motion causes an increase in attention demands, which have a greater effect on motor task rather than neuromuscular performance. **Practitioner Summary:** Minor delays or mistakes can separate life and death at sea. The safety and productivity of most vessels rely on error-free performance of motor tasks. This study demonstrates that human ability to perform motor tasks is compromised by ship motions and may aid in developing training and safety guidelines for seafarers.

- **Keywords:** motion, reaction time, visuomotor accuracy tracking, maximal voluntary contraction, voluntary activation

**Byoung-Keon Park, Matthew P. Reed. *Parametric body shape model of standing children aged 3–11 years. Pages 1714-1725.***

A statistical body shape model (SBSM) for children was developed for generating a child body shape with desired anthropometric parameters. A standardised template mesh was fit to whole-body laser scan data from 137 children aged 3–11 years. The mesh coordinates along with a set of surface landmarks and 27 manually measured anthropometric variables were analysed using principal component (PC) analysis. PC scores were associated with anthropometric predictors such as stature, body mass index (BMI) and ratio of erect sitting height to stature (SHS) using a regression model. When the original scan data were compared with the predictions of the SBSM using each subject's stature, BMI and SHS, the mean absolute error was  $10.4 \pm 5.8$  mm, and 95th percentile error was  $24.0 \pm 18.5$  mm. The model, publicly available online, will have utility for a wide range of applications. **Practitioner Summary:** A statistical body shape model for children helps to account for inter-individual variability in body shapes as well as anthropometric dimensions. This parametric modelling approach is useful for reliable prediction of the body shape of a specific child with a few given predictors such as stature, body mass index and age.

- **Keywords:** statistical body shape model, parametric modelling, anthropometry, body shape prediction, child body shape measurement

Anping Xie, Pascale Carayon, Elizabeth D. Cox, Randi Cartmill, Yaqiong Li, Tosha B. Wetterneck, Michelle M. Kelly. Application of participatory ergonomics to the redesign of the family-centred rounds proces. Pages 1726-1744.

Participatory ergonomics (PE) can promote the application of human factors and ergonomics (HFE) principles to healthcare system redesign. This study applied a PE approach to redesigning the family-centred rounds (FCR) process to improve family engagement. Various FCR stakeholders (e.g. patients and families, physicians, nurses, hospital management) were involved in different stages of the PE process. HFE principles were integrated in both the content (e.g. shared mental model, usability, workload consideration, systems approach) and process (e.g. top management commitment, stakeholder participation, communication and feedback, learning and training, project management) of FCR redesign. We describe activities of the PE process (e.g. formation

and meetings of the redesign team, data collection activities, intervention development, intervention implementation) and present data on PE process evaluation. To demonstrate the value of PE-based FCR redesign, future research should document its impact on FCR process measures (e.g. family engagement, round efficiency) and patient outcome measures (e.g. patient satisfaction). **Practitioner Summary:** The application of participatory ergonomics (PE) to healthcare system redesign is limited. This study broadens PE application from designing individual tasks in specific jobs to address physical ergonomic issues to designing complex healthcare processes to address cognitive and organisational ergonomic issues.

- **Keywords:** participatory ergonomics, family-centred rounds, healthcare system redesign, pediatric hospital, checklist

**Joost C.F. de Winter, Dimitra Dodou, Neville A. Stanton. *A quarter of a century of the DBQ: some supplementary notes on its validity with regard to accidents.* Pages 1745-1769.**

This article synthesises the latest information on the relationship between the Driver Behaviour Questionnaire (DBQ) and accidents. We show by means of computer simulation that correlations with accidents are necessarily small because accidents are rare events. An updated meta-analysis on the zero-order correlations between the DBQ and self-reported accidents yielded an overall  $r$  of .13 (fixed-effect and random-effects models) for violations (57,480 participants; 67 samples) and .09 (fixed-effect and random-effects models) for errors (66,028 participants; 56 samples). An analysis of a previously published DBQ dataset (975 participants) showed that by aggregating across four measurement occasions, the correlation coefficient with self-reported accidents increased from .14 to .24 for violations and from .11 to .19 for errors. Our meta-analysis also showed that DBQ violations ( $r = .24$ ; 6353 participants; 20 samples) but not DBQ errors ( $r = -.08$ ; 1086 participants; 16 samples) correlated with recorded vehicle speed. **Practitioner Summary:** The DBQ is probably the most widely used self-report questionnaire in driver behaviour research. This study shows that DBQ violations and errors correlate moderately with self-reported traffic accidents.

- **Keywords:** Driver Behaviour Questionnaire, errors, violations, self-reported accidents, crashes, meta-analysis