

## **Ergonomics– rok 2018, ročník 61**

### **Číslo 9**



**Steven Visser, Henk F. van der Molen, Judith K. Sluiter & Monique H. W. Frings-Dresen. *The process evaluation of two alternative participatory ergonomics intervention strategies for construction companies*. Pages: 1156-1172.**

To gain insight into the process of applying two guidance strategies – face-to-face (F2F) or e-guidance strategy (EC) – of a Participatory Ergonomics (PE) intervention and whether differences between these guidance strategies occur, 12 construction companies were randomly assigned to a strategy. The process evaluation contained reach, dose delivered, dose received, precision, competence, satisfaction and behavioural change of individual workers. Data were assessed by logbooks, and questionnaires and interviews at baseline and/or after six months. Reach was low (1%). Dose delivered (F2F: 63%; EC: 44%), received (F2F: 42%; EC: 16%) were not sufficient. The precision and competence were sufficient for both strategies and satisfaction was strongly affected by dose received. For behavioural change, knowledge (F2F) and culture (EC) changed positively within companies. Neither strategy was delivered as intended. Compliance to the intervention was low, especially for EC. Starting with a face-to-face meeting might lead to higher compliance, especially in the EC group. **Practitioner Summary:** This study showed that compliance to a face-to-face and an e-guidance strategy is low. To improve the compliance, it is advised to start with a face-to-face meeting to see which parts of the intervention are needed and which guidance strategy can be used for these parts.

- **Keywords:** Process evaluation, participatory ergonomics, guidance strategies, construction industry

**Radin Zaid Radin Umar, Carolyn M. Sommerich, Steve A. Lavender, Elizabeth Sanders & Kevin D. Evans. *Conceptual frameworks for the workplace change adoption process: elements integration from decision making and learning cycle process*. Pages: 1173-1186.**

Sound workplace ergonomics and safety-related interventions may be resisted by employees, and this may be detrimental to multiple stakeholders. Understanding fundamental aspects of decision-making, behavioural change, and learning cycles may

provide insights into pathways influencing employees' acceptance of interventions. This manuscript reviews published literature on thinking processes and other topics relevant to decision making and incorporates the findings into two new conceptual frameworks of the workplace change adoption process. Such frameworks are useful for thinking about adoption in different ways and testing changes to traditional intervention implementation processes. Moving forward, it is recommended that future research focuses on systematic exploration of implementation process activities that integrate principles from the research literature on sense-making, decision-making, and learning processes. Such exploration may provide the groundwork for development of specific implementation strategies that are theoretically grounded and provide a revised understanding of how successful intervention adoption processes work. **Practitioner summary:** Adoption and acceptance of workplace changes may be facilitated through sound implementation strategies. This manuscript explores several principles of sense-making and decision-making processes that can potentially be used by industrial practitioners to inform the design and development of implementation strategies for interventions that improve workplace ergonomics and safety.

- **Keywords:** Sense-making, adoption, acceptance, intervention effectiveness research, workplace changes

**Pieter Coenen, Genevieve N. Healy, Elisabeth A. H. Winkler, David W. Dunstan, Neville Owen, Marj Moodie, Anthony D. LaMontagne, Elizabeth A. Eakin, Peter B O'Sullivan & Leon M. Straker. *Associations of office workers' objectively assessed occupational sitting, standing and stepping time with musculoskeletal symptoms.* Pages: 1187-1195.**

We examined the association of musculoskeletal symptoms (MSS) with workplace sitting, standing and stepping time, as well as sitting and standing time accumulation (i.e. usual bout duration of these activities), measured objectively with the activPAL3 monitor. Using baseline data from the *Stand Up Victoria* trial (216 office workers, 14 workplaces), cross-sectional associations of occupational activities with self-reported MSS (low-back, upper and lower extremity symptoms in the last three months) were examined using probit regression, correcting for clustering and adjusting for confounders. Sitting bout duration was significantly ( $p < 0.05$ ) associated, non-linearly, with MSS, such that those in the middle tertile displayed the highest prevalence of upper extremity symptoms. Other associations were non-significant but sometimes involved large differences in symptom prevalence (e.g. 38%) by activity. Though causation is unclear, these non-linear associations suggest that sitting and its alternatives (i.e. standing and stepping) interact with MSS and this should be considered when designing safe work systems. **Practitioner summary:** We studied associations of objectively assessed occupational activities with musculoskeletal symptoms in office workers. Workers who accumulated longer sitting bouts reported fewer upper extremity symptoms. Total activity duration was not significantly associated with musculoskeletal symptoms. We underline the importance of considering total volumes and patterns of activity time in musculoskeletal research.

- **Keywords:** Musculoskeletal symptoms, office workers, posture, sitting, standing

**Francisco Locks, Nidhi Gupta, David Hallman, Marie Birk Jørgensen, Ana Beatriz Oliveira & Andreas Holtermann. *Association between objectively measured static standing and low back pain – a cross-sectional study among blue-collar workers.* Pages: 1196-1207.**

This study aims to investigate the cross-sectional association between objectively measured total time and temporal patterns of static standing (short bouts: 0–5 min; moderate bouts: >5–10 min; and long bouts: >10 min) during work and leisure and low back pain (LBP) among 698 blue-collar workers. Workers reported LBP on a 0–10 scale.

The association between time spent on static standing and LBP was tested with linear regression. A positive association with LBP intensity was found for long bouts of static standing ( $\beta = 0.27$ ) during total day (work + leisure), and total static standing time at leisure ( $\beta = 0.12$ ). No significant associations were found for static standing during work and LBP intensity. These findings indicate that particularly long bouts of static standing over the entire day contribute to LBP in blue-collar workers. **Practitioner Summary:** The association between LBP and static standing time was investigated. This study indicates that prolonged time standing during total day and standing during leisure are positively associated with LBP among blue-collar workers. Therefore, practitioners should consider long periods of standing as a potential risk factor for LBP.

- **Keywords:** Accelerometry, body posture, occupational health, physical activity, standing work

**Richard M. Kesler, Faith F. Bradley, Grace S. Deetjen, Michael J. Angelini, Matthew N. Petrucci, Karl S. Rosengren, Gavin P. Horn & Elizabeth T. Hsiao-Weckler. *Impact of SCBA size and fatigue from different firefighting work cycles on firefighter gait.* Pages: 1208-1215.**

Risk of slips, trips and falls in firefighters maybe influenced by the firefighter's equipment and duration of firefighting. This study examined the impact of a four self-contained breathing apparatus (SCBA) *three SCBA of increasing size and a prototype design* and three work cycles *one bout (1B), two bouts with a five-minute break (2B) and two bouts back-to-back (BB)* on gait in 30 firefighters. Five gait parameters (double support time, single support time, stride length, step width and stride velocity) were examined pre- and post-firefighting activity. The two largest SCBA resulted in longer double support times relative to the smallest SCBA. Multiple bouts of firefighting activity resulted in increased single and double support time and decreased stride length, step width and stride velocity. These results suggest that with larger SCBA or longer durations of activity, firefighters may adopt more conservative gait patterns to minimise fall risk. **Practitioner Summary:** The effects of four self-contained breathing apparatus (SCBA) and three work cycles on five gait parameters were examined pre- and post-firefighting activity. Both SCBA size and work cycle affected gait. The two largest SCBA resulted in longer double support times. Multiple bouts of activity resulted in more conservative gait patterns.

- **Keywords:** Firefighting, self-contained breathing apparatus, work cycle, gait

**Sean Hudson, Carlton Cooke, Simeon Davies, Sacha West, Raeq Gamiieldien, Chris Low & Ray Lloyd. *A comparison of economy and sagittal plane trunk movements among back-, back/front- and head-loading.* Pages: 1216-1222.**

It has been suggested that freedom of movement in the trunk could influence load carriage economy. This study aimed to compare the economy and sagittal plane trunk movements associated with three load carriage methods that constrain posture differently. Eighteen females walked at  $3 \text{ km}\cdot\text{h}^{-1}$  with loads of 0, 3, 6, 9, 12, 15 and 20 kg carried on the back, back/front and head. Load carriage economy was assessed using the Extra Load Index (ELI). Change in sagittal plane trunk forward lean and trunk angle excursion from unloaded to loaded walking were assessed. Results show no difference in economy between methods ( $p = .483$ ), despite differences in the change in trunk forward lean ( $p = .001$ ) and trunk angle excursion ( $p = .021$ ) from unloaded to loaded walking. We conclude that economy is not different among the three methods of load carriage, despite significant differences in sagittal plane trunk movements. **Practitioner summary:** This article shows, based on mean data, that there is no difference in economy among back, back/front and head-loading, despite differences in trunk

movement. It is possible a combination of factors align to influence individual economy, rather than a single set of factors, applicable to all individuals for each method.

- **Keywords:** economy, forward lean, trunk movement, Load carriage

**Yihun Jeong, Suyeon Heo, Giwhyun Lee & Woojin Park. *Pre-obesity and obesity impacts on passive joint range of motion. Pages: 1223-1231.***

Despite the prevalence of pre-obesity and obesity, the physical capabilities of pre-obese/obese individuals are not well documented. As an effort to address this, this study investigated the pre-obesity and obesity impacts on joint range of motion (RoM) for twenty-two body joint motions. A publicly available passive RoM dataset was analysed. Three BMI groups (normal-weight, pre-obese, and obese [Class I]) were statistically compared in joint RoM. The pre-obese and obese groups were found to have significantly smaller RoM means than the normal-weight for elbow flexion and supination, hip extension and flexion, knee flexion and ankle plantar flexion. The pre-obese and obese groups exhibited no significant inter-group mean RoM differences except for knee flexion; for knee flexion, the obese group had significantly smaller RoM means than the pre-obese. The findings would be useful for designing work tasks and products/systems for high BMI individuals and developing digital human models representing differently sized individuals. **Practitioner summary:** This study investigated the pre-obesity and obesity impacts on joint range of motion (RoM) by comparing three participant groups: normal-weight; pre-obese and obese. The pre-obese and obese groups had significantly smaller RoM means than the normal-weight for elbow flexion and supination; hip extension and flexion; knee flexion and ankle plantar flexion.

- **Keywords:** BMI, body flexibility, Fatness, joint mobility, overweight

**Celeste E. Coltman, Julie R. Steele & Deirdre E. McGhee. *Effects of age and body mass index on breast characteristics: a cluster analysis. Pages: 1232-1245.***

Limited research has quantified variation in the characteristics of the breasts among women and determined how these breast characteristics are influenced by age and body mass. The aim of this study was to classify the breasts of women in the community into different categories based on comprehensive and objective measurements of the characteristics of their breasts and torsos, and to determine the effect of age and body mass index on the prevalence of these breast categories. Four breast characteristic clusters were identified (X-Large, Very-ptotic & Splayed; Large, Ptotic & Splayed; Medium & Mildly-ptotic; and Small & Non-ptotic), with age and BMI shown to significantly affect the breast characteristic clusters. These results highlight the difference in breast characteristics exhibited among women and how these clusters are affected by age and BMI. The breast characteristic clusters identified in this study could be used as a basis for future bra designs and sizing systems in order to improve bra fit for women. **Practitioner summary:** This original research provides evidence for bra designers and manufacturers on the diverse breast characteristics exhibited by women within the population and the significant effect that both body mass index and age have on the breast characteristic clusters. Future bra designs should consider the variation in breast characteristics among women.

- **Keywords:** Breast characteristics, age, body mass index

**Khairil Anas Md Rezali & Michael J. Griffin. *Transmission of vibration through glove materials: effects of contact force. Pages: 1246-1258.***

This study investigated effects of applied force on the apparent mass of the hand, the dynamic stiffness of glove materials and the transmission of vibration through gloves to

the hand. For 10 subjects, 3 glove materials and 3 contact forces, apparent masses and glove transmissibilities were measured at the palm and at a finger at frequencies in the range 5–300 Hz. The dynamic stiffnesses of the materials were also measured. With increasing force, the dynamic stiffnesses of the materials increased, the apparent mass at the palm increased at frequencies greater than the resonance and the apparent mass at the finger increased at low frequencies. The effects of force on transmissibilities therefore differed between materials and depended on vibration frequency, but changes in apparent mass and dynamic stiffness had predictable effects on material transmissibility. Depending on the glove material, the transmission of vibration through a glove can be increased or decreased when increasing the applied force. **Practitioner summary:** Increasing the contact force (i.e. push force or grip force) can increase or decrease the transmission of vibration through a glove. The vibration transmissibilities of gloves should be assessed with a range of contact forces to understand their likely influence on the exposure of the hand and fingers to vibration.

- **Keywords:** Anti-vibration gloves, biodynamics, transmissibility, impedance, hands, fingers

**N. Zhang, M. Fard, M. H. U. Bhuiyan, D. Verhagen, M. F. Azari & S. R. Robinson. *The effects of physical vibration on heart rate variability as a measure of drowsiness. Pages: 1259-1272.***

We investigated the effects of low frequency whole body vibration on heart rate variability (HRV), a measure of autonomic nervous system activation that differentiates between stress and drowsiness. Fifteen participants underwent two simulated driving tasks for 60 min each: one involved whole-body 4–7 Hz vibration delivered through the car seat, and one involved no vibration. The Karolinska Sleepiness Scale (KSS), a subjective measure of drowsiness, demonstrated a significant increase in drowsiness during the task. Within 15–30 min of exposure to vibration, autonomic (sympathetic) activity increased ( $p < .01$ ) in response to the stress of maintaining alertness and performance when drowsy, and peaked at 60 min ( $p < .001$ ). Changes in three other HRV domains [higher LF/HF ratios, lower RMSSD (ms) and pNN50 (%) values] were consistent with increased sympathetic activation. These findings have implications for the future development of equivalent drowsiness contours leading to improvements in road safety. **Practitioner summary:** The effects of physical vibration on driver drowsiness have not been well investigated. This laboratory-controlled study found characteristic changes in heart rate variability (HRV) domains that indicated progressively increasing neurological effort in maintaining alertness in response to low frequency vibration, which becomes significant within 30 min.

- **Keywords:** Attention, drowsiness, mental workload, autonomic nervous system (ans), vibration, driving

**Michael Antoun, Ding Ding, Erika E. Bohn-Goldbaum, Scott Michael & Kate M. Edwards. *Driving in an urban environment, the stress response and effects of exercise. Pages: 1273-1281.***

Driving may be detrimental to health, with one hypothesis suggesting that driving may elicit an acute stress response and, with repeated exposures, may become a chronic stressor. The present study examined the stress response to driving and the effectiveness of a prior exercise bout in dampening this response. Twenty healthy adults performed three tasks: control, driving and exercise plus driving. Heart rate (HR), heart rate variability (HRV), blood pressure (BP) and cortisol were measured to quantify the acute stress response to each condition. Data indicated a stress response to driving: HR was elevated and HRV was reduced during the driving task compared with control. HR was elevated and HRV was reduced comparing the exercise plus driving with the driving condition. BP and cortisol were not different among conditions. The potential of

interventions, such as exercise, to counter daily stressors should be evaluated to safeguard long-term health. **Practitioner Summary:** this study confirms that driving induces a stress response, with the exercise intervention providing mixed results (an increase in cardiovascular measures and a decrease in cortisol measure trending significance). Given the known consequences of stress and evidence that exercise can mitigate acute stress, further evaluation of exercise interventions is recommended.

- **Keywords:** Driving, stress, cortisol, heart rate variability, cardiovascular disease

**Kevin Le Goff, Arnaud Rey, Patrick Haggard, Olivier Oullier & Bruno Berberian. *Agency modulates interactions with automation technologies.* Pages: 1282-1297.**

The increasing presence of automation between operators and automated systems tends to disrupt operators from action outcomes, leading them to leave the control loop. The theoretical framework of agency suggests that priming the operator about the system's upcoming behaviour could help restore an appropriate sense of control and increase user acceptance of what the system is doing. In a series of two experiments, we test whether providing information about what the system is about to do next leads to an increase in the level of user acceptance, concomitant with an increase in control and performance. Using an aircraft supervision task, we demonstrated the benefit of prime messages regarding system acceptance and performance. Taken together, our results indicate that the principles proposed by this framework could be used to improve human-machine interaction and maintain a high level of sense of control in supervisory tasks.

**Practitioner Summary:** The out-of-the-loop performance problem is a major potential consequence of automation, leaving operators helpless to takeover automation in case of failure. Using an aircraft supervision task, the following article illustrates how the psychological approach of agency can help improving human-system interactions by designing more acceptable and more controllable automated interfaces

- **Keywords:** Vehicle ergonomics, attention and vigilance, information displays, human-computer interaction, team working