

## **Ergonomics– rok 2014, ročník 57**

### **Číslo 5**



**Ke Chen & Alan Hoi Shou Chan. *Gerontechnology acceptance by elderly Hong Kong Chinese: a senior technology acceptance model (STAM)*. pages 635-652.**

The purpose of this study was to develop and test a senior technology acceptance model (STAM) aimed at understanding the acceptance of gerontechnology by older Hong Kong Chinese people. The proposed STAM extended previous technology acceptance models and theories by adding age-related health and ability characteristics of older people. The proposed STAM was empirically tested using a cross-sectional questionnaire survey with a sample of 1012 seniors aged 55 and over in Hong Kong. The result showed that STAM was strongly supported and could explain 68% of the variance in the use of gerontechnology. For older Hong Kong Chinese, individual attributes, which include age, gender, education, gerontechnology self-efficacy and anxiety, and health and ability characteristics, as well as facilitating conditions explicitly and directly affected technology acceptance. These were better predictors of gerontechnology usage behaviour (UB) than the conventionally used attitudinal factors (usefulness and ease of use). Practitioner Summary: Previous studies have not given much consideration to age-related health and associated abilities when examining acceptance of technology by the ageing population. By encompassing conventional technology acceptance constructs together with age-related health and ability characteristics, the present study was able to identify more factors affecting gerontechnology acceptance by older Hong Kong Chinese.

- **Keywords:** facilitating conditions, gerontechnology, health and ability characteristics, Hong Kong Chinese, senior technology acceptance model

**Jiahong Song & Xingda Qu. *Effects of age and its interaction with task parameters on lifting biomechanics*. pages 653-668.**

This study investigated the age-related differences in lifting biomechanics. Eleven younger and 12 older participants were instructed to perform symmetric lifting tasks defined by different combinations of destination heights and load magnitudes. Lifting biomechanics was assessed. It was found that the trunk flexion in the starting posture was 32% lower and the peak trunk extension velocity was 46% lower in older participants compared with those in younger ones, indicating that older adults tended to use safer lifting strategies than did younger adults. Based on these findings, we recommend that physical exercise programmes may be a more effective ergonomic

intervention for reducing the risks of low back pain (LBP) in lifting among older workers, compared with instructions of safe lifting strategies. As for younger workers, instructions of safe lifting strategies would be effective in LBP risk reduction. **Practitioner Summary:** Low back pain incidence is often associated with manual lifting and is more prevalent among older workers. An experiment was conducted to investigate the age-related differences in lifting biomechanics. The results showed that older adults tended to use safer lifting strategies compared with young adults.

- **Keywords:** low back pain, age, destination height, load magnitude, lifting biomechanics

**Juha Oksa, Sanna Hosio, Tero Mäkinen, Harri Lindholm, Hannu Rintamäki, Sirkka Rissanen, Jari Latvala, Kimmo Vaara & Panu Oksa. *Muscular, cardiorespiratory and thermal strain of mast and pole workers.* pages 669-678.**

This field study evaluated the level of muscular, cardiorespiratory and thermal strain of mast and pole workers. We measured the muscular strain using electromyography (EMG), expressed as a percentage in relation to maximal EMG activity (%MEMG). Oxygen consumption ( $VO_2$ ) was indirectly estimated from HR measured during work and expressed as a percentage of maximum  $VO_2$  (% $VO_{2max}$ ). Skin and deep body temperatures were measured to quantify thermal strain. The highest average muscular strain was found in the wrist flexor ( $24 \pm 1.5\%$ MEMG) and extensor ( $21 \pm 1.0\%$ MEMG) muscles, exceeding the recommendation of 14%MEMG. Average cardiorespiratory strain was  $48 \pm 3\%$  $VO_{2max}$ . Nearly half (40%) of the participants exceeded the recommended 50% $VO_{2max}$  level. The core body temperature varied between 36.8°C and 37.6°C and mean skin temperature between 28.6°C and 33.4°C indicating possible occasional superficial cooling. Both muscular and cardiorespiratory strain may pose a risk of local and systemic overloading and thus reduced work efficiency. Thermal strain remained at a tolerable level. **Practitioner Summary:** This field study shows that mast and pole workers may be at risk for local and/or systemic muscular and cardiorespiratory overloading and thus for excessive fatigue. The results emphasise the importance of good fitness level and they may be applied to other similar occupations as well.

- **Keywords:** physical strain, fatigue, field study, work at height, temperature, ambient conditions

**P. Matsangas, M.E. McCauley, G. Gehl, J. Kiser, A. Bandstra, J. Blankenship & E. Pierce. *Motion-induced interruptions and postural equilibrium in linear lateral accelerations.* pages 679-692.**

This study assesses lateral tipping motion-induced interruptions (MIIs) in a simulated motion environment. The objective is to revisit MII occurrence and sway motion relationship by focusing on the frequency and acceleration of the lateral motion stimulus. Results verify that MIIs increase with increasing peak sway acceleration, but the effect of sway frequency is not as clear as that of acceleration. Complex multidirectional motions create more tipping MIIs than unidirectional motion. Research should incorporate acceleration, frequency and motion complexity as factors influencing MII occurrence. To describe a temporary loss of balance without tipping, the term 'probable' MII is introduced. This term fills the gap between the theoretical definition and a human-centred perception of an MII where loss of balance is not a binary phenomenon. The 'probable' MIIs were 16–67% more common than the 'definite' MIIs. The developed mathematical model of MII occurrence versus sway acceleration (amplitude, frequency) approximated the observed MIIs with less than 9% difference. **Practitioner Summary:** Motion-induced interruptions (MIIs) are important for operational readiness at sea. The rigid body model to predict MIIs does not include the effect of frequency of motion and

lacks a human-centred approach. This study identifies that frequency and motion complexity are associated with MII occurrence and proposes a human-oriented extension of the existing MII definition.

- **Keywords:** motion-induced interruptions, lateral motion, postural equilibrium, human performance modelling

**Zhen Zhou & Michael J. Griffin. *Response of the seated human body to whole-body vertical vibration: biodynamic responses to sinusoidal and random vibration.* pages 693-713.**

The dependence of biodynamic responses of the seated human body on the frequency, magnitude and waveform of vertical vibration has been studied in 20 males and 20 females. With sinusoidal vibration (13 frequencies from 1 to 16 Hz) at five magnitudes (0.1–1.6 ms<sup>-2</sup> r.m.s.) and with random vibration (1–16 Hz) at the same magnitudes, the apparent mass of the body was similar with random and sinusoidal vibration of the same overall magnitude. With increasing magnitude of vibration, the stiffness and damping of a model fitted to the apparent mass reduced and the resonance frequency decreased (from 6.5 to 4.5 Hz). Male and female subjects had similar apparent mass (after adjusting for subject weight) and a similar principal resonance frequency with both random and sinusoidal vibration. The change in biodynamic response with increasing vibration magnitude depends on the frequency of the vibration excitation, but is similar with sinusoidal and random excitation. **Practitioner Summary:** Biodynamic responses (e.g. body resonances) influence vibration discomfort and are studied with random vibration, whereas psychological responses to vibration are studied with sinusoidal vibration. Vibration in transport includes both random and sinusoidal vibration. This study shows the frequency-dependence and magnitude-dependence of biodynamic responses are similar with random and sinusoidal vibration.

- **Keywords:** biodynamics, vibration magnitude, apparent mass, force, non-linearity, frequency weighting

**Zhen Zhou & Michael J. Griffin. *Response of the seated human body to whole-body vertical vibration: discomfort caused by sinusoidal vibration.* pages 714-732.**

Frequency weightings for predicting vibration discomfort assume the same frequency-dependence at all magnitudes of vibration, whereas biodynamic studies show that the frequency-dependence of the human body depends on the magnitude of vibration. This study investigated how the frequency-dependence of vibration discomfort depends on the acceleration and the force at the subject–seat interface. Using magnitude estimation, 20 males and 20 females judged their discomfort caused by sinusoidal vertical acceleration at 13 frequencies (1–16 Hz) at magnitudes from 0.1 to 4.0 ms<sup>-2</sup> r.m.s. The frequency-dependence of their equivalent comfort contours depended on the magnitude of vibration, but was less dependent on the magnitude of dynamic force than the magnitude of acceleration, consistent with the biodynamic non-linearity of the body causing some of the magnitude-dependence of equivalent comfort contours. There were significant associations between the biodynamic responses and subjective responses at all frequencies in the range 1–16 Hz. **Practitioner Summary:** Vertical seat vibration causes discomfort in many forms of transport. This study provides the frequency-dependence of vibration discomfort over a range of vibration magnitudes and shows how the frequency weightings in the current standards can be improved.

- **Keywords:** ride comfort, frequency weighting, vibration magnitude, force

**Máire Curran, Wim Dankaerts, Peter O'Sullivan, Leonard O'Sullivan & Kieran O'Sullivan.** *The effect of a backrest and seatpan inclination on sitting discomfort and trunk muscle activation in subjects with extension-related low back pain.* pages 733-743.

Few studies have demonstrated that seating modifications reduce low back pain (LBP). One recent study found that a forward-inclined seatpan reduced low back discomfort (LBD), however this was only examined in people with flexion-related LBP. No study has yet investigated its effectiveness among people with extension-related LBP. This crossover study examined 12 subjects with extension-related LBP. Sitting discomfort and surface electromyography of three trunk muscles were recorded during a 10-minute typing task while sitting with two different seatpan inclinations, both with and without a backrest. LBD ( $p < 0.001$ ) and overall body discomfort (OBD) ( $p = 0.016$ ) were significantly greater on the forward-inclined seatpan. The backrest did not alter trunk muscle activation or sitting discomfort. The results demonstrate that in a specific subgroup of people with extension-related LBP, increasing forward seatpan inclination significantly increased LBD and OBD. Future research should consider matching ergonomics prescriptions according to the individual presentation of people with LBP.

**Practitioner Summary:** Sitting on a forward-inclined seatpan resulted in greater low back discomfort and overall body discomfort than sitting on a flat seatpan during a typing task among people with extension-related low back pain (LBP). Future research should examine matching ergonomics prescriptions to the individual presentation of people with LBP.

- **Keywords:** back pain, musculoskeletal disorders, seating, office ergonomics

**Tyson A.C. Beach, David M. Frost, Stuart M. McGill & Jack P. Callaghan.** *Physical fitness improvements and occupational low-back loading – an exercise intervention study with firefighters.* pages 744-763.

The impact of exercise on firefighter job performance and cardiorespiratory fitness has been studied extensively, but its effect on musculoskeletal loading remains unknown. The aim of this study was to contrast the physical fitness and low-back loading outcomes of two groups of firefighters who completed different exercise programmes. Before and after 12 weeks of exercise, subjects performed a physical fitness test battery, the Functional Movement Screen™ (FMS) and simulated job tasks during which peak L4/L5 joint compression and reaction shear forces were quantified using a dynamic biomechanical model. Subjects who exercised exhibited statistically significant improvements ( $p < 0.05$ ) in body composition, cardiorespiratory fitness, muscular strength, power, endurance and flexibility, but FMS scores and occupational low-back loading measures were not consistently affected. Firefighters who are physically fit are better able to perform essential job duties and avoid cardiac events, but short-term improvements in physical fitness may not necessarily translate into reduced low-back injury risk. **Practitioner Summary:** Firefighters must be physically fit to safely and effectively meet the demands of their work, but improvements in physical fitness alone may not necessarily reduce their low-back injury risk.

- **Keywords:** injury prevention, biomechanics, motor behaviour

**Tina A. Greenlee, Gavin Horn, Denise L. Smith, George Fahey, Eric Goldstein & Steven J. Petruzzello.** *The influence of short-term firefighting activity on information processing performance.* pages 764-773.

This study examined the following: effects of simulated firefighting (FF) activities under heat stress on sustained attention; whether incident rehabilitation (IR) influences

performance; and relationships between performance, affect and personality. Firefighters performed -18 min of FF. Attention, physiological, perceptual and psychological assessments were made before and after FF, IR and recovery. IR had no effects. Self-rated Energy increased, Tiredness decreased and Anxiety increased immediately post-FF; all returned to baseline 120 min post. The immediate effect of FF was faster reaction time (RT) followed by slowing after recovery. Perceived Energy at baseline was associated ( $p$ -values < 0.05) with faster and Tiredness with slower post-FF RTs; Accuracy was unaffected. Conscientiousness was negatively associated with RT before and 120 min following FF. RTs were faster following FF, accuracy was unchanged. Higher baseline Energy/lower Tiredness were associated with faster, less variable RTs at baseline and post-FF. Those with higher Conscientiousness had faster RTs. Research should further investigate higher-level cognitive processing following, or ideally during, FF. **Practitioner Summary:** This study examined the effects of simulated firefighting (FF) activities on sustained attention and affect. Energy and Anxiety increased, Tiredness decreased immediately post-FF. The immediate effect of FF was faster reaction time (RT) followed by slowing after recovery; accuracy was unaffected. Higher baseline Energy/lower Tiredness were associated with faster, less variable RTs.

- **Keywords:** cognitive processing, reaction time, firefighting, anxiety, energy

**Sheridan A. Gho, Bridget J. Munro, Sandra C. Jones & Julie R. Steele.** *Evidence-based recommendations for building better bras for women treated for breast cancer. pages 774-786.*

Participating in exercise is beneficial for women who have been treated for breast cancer. However, not being able to find a comfortable exercise bra can be a barrier to exercise participation. This study aimed to systematically investigate what breast support women treated for breast cancer want when they exercise in order to provide evidence-based recommendations to improve exercise bra designs for these women. Based on 432 responses from a national online survey, frequency and relationship data were analysed (binary logistic regression) to understand exercise bra issues pertinent to this population. These issues included being able to control for asymmetrical cup sizes, managing heightened skin sensitivity, managing fluid (size) fluctuations, managing a prosthesis and restoring body image by restoring shape. This study provides evidence-based recommendations to inform an exercise bra design that will meet the unique needs of women treated for breast cancer. Rigorous, evidence-based evaluations of exercise bras for women treated for breast cancer may contribute to their well-being and quality of life through enhanced designs. **Practitioner Summary:** Exercise bras worn by women treated for breast cancer were investigated with the aim of improving exercise bra designs, which may ultimately contribute to the well-being and quality of life of these women. Evidence-based recommendations to inform an exercise bra design for women treated for breast cancer are provided.

- **Keywords:** Breast cancer, bra design, bra discomfort, women's health, exercise

**Laura Delgado-Abellán, Xavier Aguado, Ester Jiménez-Ormeño, Laura Mecerreyes & Luis M. Alegre.** *Foot morphology in Spanish school children according to sex and age. pages 787-797.*

The aim of this study was to analyse the differences in foot dimensions in a sample of Spanish school-aged children. A total of 497 boys and 534 girls from Spain participated in the study. Measurements of both feet were obtained using a 3D foot digitiser, and shoe sizes were recorded and then estimated based on foot length measurements. The variations in foot measurements underwent a gradual increase with age in both boys and girls. Gender differences appeared at the age of 8–9 years, when the girls in the sample were found to wear smaller shoes than those they should have worn. Most foot dimensions begin to differ between boys and girls at the age of 8 years. The girls in the

sample studied used footwear that was too small for their foot length, probably because they looked for a better width fit. **Practitioner Summary:** There is a lack of data on the foot morphology of Spanish school children. We found gender differences in foot morphology, and observed that the girls were not using optimally fitting shoes. These results could be useful for the design of age- and gender-specific children's footwear.

- **Keywords:** footwear, foot dimensions, children, 3D foot digitiser