

## **Ergonomics– rok 2020, ročník 63**

### **Číslo 9**



**Michael Mutz, Sascha Abdel Hadi & Jan Alexander Häusser. *Work and sport: relationships between specific job stressors and sports participation*. Pages: 1077-1087.**

This study examines the relationships between different job stressors and sports participation. Based on a large-scale representative sample (N = 1935), the paper tested if the number of different job stressors encountered in a job is related to sports participation. Moreover, we examined the relative impact of different stressors on sport participation. As predicted, the number of stressors encountered at work is negatively associated with leisure-time sports participation. When testing the relative effects of different job stressors, intense physical labour, shift and night work, and job insecurity (i.e. having a fixed-term contract or fearing unemployment) are negatively related to sports participation, whereas hazardous exposure (i.e. noise), bad working atmosphere, and long working hours are not related to sports participation. Hence, the total number of job stressors, but also the specificity of job stressors, should be taken into account by professionals in the fields of health research and physical activity promotion. **Practitioner summary:** In a large-scale representative sample, we examined if different adverse job conditions are negatively related to sports participation. We found that the number of different job stressors was negatively related to sports participation. In particular, intense physical labour, shift and night work as well as job insecurity had an impact.

- **Keywords:** Physical activity, sports activity, working conditions, occupational health, health promotion

**Corinna Peifer, Juergen Sauer & Conny H. Antoni. *Effects of social stress on performance and strain in complex multiple task environments*. Pages: 1088-1100.**

While stress has been an important research area in the field of ergonomics, research on social stress and on the combination of stressors is largely lacking. This study examined the effects of social stress on psychological and physiological strain and performance. As an exploratory research question we looked at the combined effects of social stress and noise. Fifty-one male student participants were tested for 2 h using a computer-based simulation of a process control environment with multiple tasks. Social stress (TSST) and

noise (80 dB) were varied experimentally. During the task, we repeatedly measured primary and secondary task performance, subjective strain, and psychophysiological strain (cortisol, heart rate). We found a main effect of social stress on physiological strain, both on cortisol and heart rate, but no main effects of social stress on subjective strain and performance. These results suggest that maintaining performance under stress comes at the cost of physiological strain. **Practitioner summary:** Although the presence of social stress is common at work, little experimental work has been done. Our experiment provides empirical evidence for negative effects of social stress on physiological stress responses while subjective strain and performance decrements could not be detected.

- **Keywords:** Social stress, noise, subjective strain, physiological strain, performance

**Luis Oliveira, Stewart Birrell & Rebecca Cain. *How technology can impact customer-facing train crew experiences.* Pages: 1101-1115.**

Customer-facing train crew members have to follow strict procedures to guarantee that trains are safe and run on time. They are also responsible for revenue protection and customer care. Human factors and ergonomics research are instrumental to understand the safety-critical aspects and improve work. We bring user experience research and personas to describe how train crew perceive their routines and how new technology may impact them. We conducted 7 hours of interviews and 30 hours of shadowing observations with the train crew ( $N = 22$ ) to provide an understanding of who are they and to define their experiences. We present the crew's current routines and created two personas to represent them. One is slightly reluctant to adopt the proposed technology, whereas the other is more accepting. Results indicate how such technology may affect crew work ergonomics and experiences, and suggest which valuable aspects should be maintained, for example the positive interactions with passengers. **Practitioner summary:** This study investigated the work routines of the customer-facing train crew. Interviews and shadowing were conducted with 22 crew from a large operator in the UK. Personas were created to represent them. Results show their preferred activities and how these would be affected by the introduction of new technology.

- **Keywords:** Personas, user experience, crew, innovation, railways

**Aya Hussein, Sondoss Elsayah & Hussein A. Abbass. *The reliability and transparency bases of trust in human-swarm interaction: principles and implications.* Pages: 1116-1132.**

Automation reliability and transparency are key factors for trust calibration and as such can have distinct effects on human reliance behaviour and mission performance. One question that remains unexplored is: what are the implications of reliability and transparency on trust calibration for human-swarm interaction? We investigate this research question in the context of human-swarm interaction, as swarm systems are becoming more popular for their robustness and versatility. Thirty-two participants performed swarm-based tasks under different reliability and transparency conditions. The results indicate that trust, whether it is reliability- or transparency-based, indicates high reliance rates and shorter response times. Reliability-based trust is negatively correlated with correct rejection rates while transparency-based trust is positively correlated with these rates. We conclude that reliability and transparency have distinct effects on trust calibration. **Practitioner Summary:** Reliability and transparency have distinct effects on trust calibration. Findings from our human experiments suggest that transparency is a necessary design requirement if and when humans need to be involved in the decision-loop of human-swarm systems, especially when swarm reliability is high.

- **Keywords:** Complacency, reliability, reliance, human-swarm teaming

**Gilvan V. da Silva, Gregory F. Zehner & Jeffrey A. Hudson. *Comparison of univariate and multivariate anthropometric design requirements methods for flight deck design application*. Pages: 1133-1149.**

Designing aircraft cockpits to accommodate the wide range of body sizes and shapes existing in the world population has always been a difficult problem for crew station engineers. There is no consensus on the best method for obtaining measurements for body forms that statistically represent the variation within a population. The aim of this research is to compare the two most commonly used anthropometric approaches for dimension specification and flight deck design: the boundary cases multivariate and the percentile univariate. The multivariate approach captured more subjects than the percentile approach ( $p < .05$ ) for all accommodation assessments using Brazilian Air Force pilots' anthropometry, but was not as effective as had been suggested in the literature. This study showed that the Boundary Cases Multivariate Method was better at evaluating design criteria for cockpit accommodation than the Percentile Univariate Method for accommodation of the central 90% envelope for the Brazilian Air Force crew application. **Practitioner summary:** The findings show that the Multivariate Boundary Cases approach can better provide anthropometric limits for the desired accommodation level when multiple body dimensions need to be simultaneously considered in a design. It will help researchers, designers, and engineers to solve complex design situations, make improved judgement and take right decisions.

- **Keywords:** Principal component analysis, cockpit design, anthropometry, multivariate, accommodation

**Yu Huang, Penglin Zhang & Shihao Liang. *Apparent mass of the seated human body during vertical vibration in the frequency range 2–100 Hz*. Pages: 1150-1163.**

We studied the apparent mass during vertical whole-body vibration in the frequency range 2–100 Hz at four magnitudes (sinusoidal sweep signals, 1.0, 1.5, 2.0 and  $2.5 \text{ ms}^{-2}$  r.m.s.) in 12 males and 12 females with upright and relaxed sitting postures. The first two peaks of apparent mass decreased with increasing vibration magnitude with both postures. The non-linearity characteristics became obscured at the two largest magnitudes and were less transparent with relaxed sitting posture. The peak frequencies and the normalised apparent masses were similar between males and females with both postures. The standardised three degrees-of-freedom parametric model with modified parameters was proposed to predict well the apparent mass of seated human body during vertical vibration in the frequency range 2–100 Hz and in the magnitude range  $1.0\text{--}2.5 \text{ ms}^{-2}$  r.m.s. **Practitioner summary:** This study shows the frequency-dependence and magnitude-dependence of biodynamic responses in the frequency range of 2–100 Hz. The magnitude of apparent mass at frequencies above 20 Hz may not be negligible. The proposed 3 DOF model with modified parameters would help with understanding and developing the human-seat system.

- **Keywords:** Whole-body vibration, seating, apparent mass, non-linearity, biodynamics

**Jonas Vinstrup, Markus D. Jakobsen, Pascal Madeleine & Lars L. Andersen. *Biomechanical load during patient transfer with assistive devices: Cross-sectional study*. Pages: 1164-1174.**

This study utilised a cross-sectional design to perform measurements of muscle activity as well as forward - and lateral trunk inclination angle during a full workday among 52 female healthcare workers from 16 different departments at five Danish hospitals. Using linear mixed models, the 95th percentile ranks of the normalised root mean square

(nRMS) values were analysed for the different types of assistive devices. Compared to no assistive device (mean nRMS 27.9%, 95% CI 24.8%–31.0%), the use of intelligent beds (23.9%, CI 20.2%–27.6%) and ceiling-lifts (24.0%, CI 20.3%–27.7%) led to lower erector spinae nRMS values across all types of patient transfers. Conversely, the use of bedsheets (30.6%, CI 27.1%–34.2%), sliding-sheets (30.3%, CI 26.8%–33.9%) and sliding-boards (33.5%, CI 29.5%–37.6%) were associated with higher levels of erector spinae muscle activity. Consistent use of ceiling-lifts and intelligent beds reduces the physical workload and may thereby decrease the risk of musculoskeletal disorders among healthcare workers. **Practitioner Summary:** Frequent patient transfer is associated with an increased risk of back pain and injury among healthcare workers. This analysis compares the level of physical load during patient transfer with commonly used assistive devices. The results show that use of the ceiling-lift and intelligent bed is associated with relatively low physical load during patient transfer.

- **Keywords:** Electromyography, patient transfer, low-back pain, healthcare, fatigue

**Danielle M. Vickery-Howe, Anthea C. Clarke, Jace R. Drain, Ben J. Dascombe & Kane J. Middleton. *No physiological or biomechanical sex-by-load interactions during treadmill-based load carriage. Pages: 1175-1181.***

This study investigated whether physiological demand or gait mechanics differ between sexes during treadmill load carriage. Female ( $n = 15$ ) and male ( $n = 15$ ) military recruit-type participants with no load carriage experience completed three 10-minute walking trials at a self-selected speed with increasing relative body-borne loads (0%, 20%, and 40% body weight). A range of cardiorespiratory, perceptual and biomechanical variables were measured. Self-selected walking speed was similar between sexes ( $4.6\text{--}4.8\text{ km}\cdot\text{h}^{-1}$ ,  $p > .05$ ) and there were no significant sex-by-load interactions for any variables. Absolute  $\text{VVO}_2$  and  $\text{VVC}_2$  were greater in males (difference  $175\text{--}178\text{ mL}\cdot\text{min}^{-1}$ ,  $p < .001$ ), however, when relative to body mass,  $\text{VVO}_2$  was similar between sexes ( $p > .05$ ). Across all loads, cadence was  $7 \pm 2\text{ steps}\cdot\text{min}^{-1}$  faster ( $p = .004$ ) and stance time was  $0.06 \pm 0.02\text{ s}$  shorter ( $p = .013$ ) in females. Increasing load resulted in greater physiological demand, cadence, % stance time, and step length ( $p < .05$ ). **Practitioner summary:** Literature comparing physiological and biomechanical variables between sexes during load carriage is scarce. Physiological and biomechanical sex differences were limited to relative measures associated with physical size (height and mass). Future research may pool male and female participants when conducting trials up to ten minutes in length.

- **Keywords:** gait, physiological demand, kinematics, spatiotemporal, military ergonomics

**Amrita Dutta, Scott P. Breloff, Fei Dai, Erik W. Sinsel, Christopher M. Warren, Robert E. Carey & John Z. Wu. *Effects of working posture and roof slope on activation of lower limb muscles during shingle installation. Pages: 1182-1193.***

Awkward and extreme kneeling during roofing generates high muscular tension which can lead to knee musculoskeletal disorders (MSDs) among roofers. However, the combined impact of roof slope and kneeling posture on the activation of the knee postural muscles and their association to potential knee MSD risks among roofers have not been studied. The current study evaluated the effects of kneeling posture and roof slope on the activation of major knee postural muscles during shingle installation via a laboratory assessment. Maximum normalized electromyography (EMG) data were collected from knee flexor and extensor muscles of seven subjects, who mimicked the shingle installation process on a slope-configurable wooden platform. The results

revealed a significant increase in knee muscle activation during simulated shingle installation on sloped rooftops. Given the fact that increased muscle activation of knee postural muscles has been associated with knee MSDs, roof slope and awkward kneeling posture can be considered as potential knee MSD risk factors. **Practitioner Summary:** This study demonstrated significant effects of roof slope and kneeling posture on the peak activation of knee postural muscles. The findings of this study suggested that residential roofers could be exposed to a greater risk of developing knee MSDs with the increase of roof slope during shingle installation due to increased muscle loading.

- **Keywords:** Ergonomics, knee injury, risk assessment, construction safety

**Dan Anton, Matthew Bray, Jennifer A. Hess, Douglas L. Weeks, Laurel D. Kincl & Amelia Vaughan. *Prevalence of work-related musculoskeletal pain in masonry apprentices. Pages: 1194-1202.***

The construction industry, specifically masonry, reports more work-related musculoskeletal disorders (WMSD) rates than the general industry. Masonry apprentices are assumed to be healthy, yet may have WMSDs. The purpose of this study was to evaluate the prevalence of musculoskeletal symptoms (MSS), time loss, and healthcare use among apprentices. 183 brick and block masonry apprentices completed surveys on demographics, work history, MSS, and functional well-being. The prevalence of MSS was calculated by body region, time loss, and healthcare use. The relationship between MSS, and perceived global physical and mental health was assessed. Approximately 78% of apprentices reported MSS, most in several body regions. Low back and wrists/hands were most prevalent, although few missed work or sought healthcare. Lower functional health and well-being was reported. Apprentices reported MSS comparable to previous studies of journey-level masons. Apprenticeship programmes could integrate ergonomics education to help apprentices develop safety culture early in their careers. **Practitioner Summary:** New masonry workers (apprentices) are assumed to be healthy yet work-related musculoskeletal symptoms (MSS) may be common early in their career. The prevalence of MSS was assessed among apprentices. Approximately 78% of apprentices reported MSS, most in several body regions, comparable to journey-level masons.

- **Keywords:** Building and construction ergonomics, intervention effectiveness, training, musculoskeletal disorders