

Ergonomics– rok 2021, ročník 64

Číslo 3



Jin Wang, Jin-Yi Zhi, Yang Du, Ze-Rui Xiang, Shu Feng & Jian-Ping Chen.
A method identifying key optimisation points for aircraft seat comfort.
Pages: 287-304.

Seating is the overriding factor influencing aircraft cabin comfort. To efficiently enhance seat comfort, this paper proposes a method to identify key optimisation points for seat comfort. Seat discomfort indicators are recognised based on a comparison of perceived performance with expectation. Confirmatory factor analysis is used to explore the latent variables of discomfort indicators, and a structural model was used to analyse correlations between latent variables. Finally, the most important latent variable influencing seat comfort was clarified. Analysis results of survey data from narrow-body aircraft show that seat discomfort indicators centre on the physical performance of the seat and include four latent variables: support performance, personal space, contact surface features, and safety and stability. Support performance determines body posture while travelling and is the overriding latent variable influencing seat comfort. This research establishes aircraft seat discomfort indicators, latent variables formed through the mutual linkage of discomfort indicators, and the structural relations between latent variables. The results can assist in the formulation of comfort optimisation procedures for aircraft seats. **Practitioner summary:** A method identifying the key points of aircraft seat comfort optimisation was proposed, which includes three steps: recognising discomfort indicators, exploring the relationship between discomfort indicators, and confirming the most important variable influencing seat comfort. Results provide guidance for aircraft seat optimisation.

- **Keywords:** Aircraft seat, comfort, assessment method, structural equation modelling (SEM) supporting performance

Jemma L. Coleman, Frank Morelli, Jodie McClelland & Kane J. Middleton.
Can target effects or discomfort ratings discriminate between small-arms weapon configurations? Pages: 305-314.

Defence acquisitions use accuracy measures as a discriminating factor in weapon purchases, but assessments are generally completed in static, supported postures at static targets with few differences being seen between configurations. The aim of this

study was to investigate whether an assessment requiring repositioning between shots could reveal differences. Participants shot at a static target under four conditions: an unweighted rifle and the addition of a mass fixed at three different positions. Accuracy and timing as well as discomfort measures were captured and compared. Hit percentage, consistency and timing varied over time, and timing increased with the addition of mass in two out of the three conditions. There was an increase in discomfort with the addition of mass further from the participant. The results showed that relying on accuracy and consistency measures alone to make acquisition decisions could have the consequence of purchasing equipment not fit for the human. **Practitioner Summary:** This research shows that relying on accuracy and consistency measures alone to make weapon–system acquisition decisions could have the consequence of purchasing equipment not fit for the user. Further research should focus on ‘upstream’ issues such as muscle fatigue and aim point stability in order to better understand human–weapon–system interactions.

- **Keywords:** Acquisition, accuracy, weapon, design

Craig K. Allison, James M. Fleming, Xingda Yan, Roberto Lot & Neville A. Stanton. *Adjusting the need for speed: assessment of a visual interface to reduce fuel use.* Pages: 315-329.

Previous research has identified that fuel consumption and emissions can be considerably reduced if drivers engage in eco-driving behaviours. However, the literature suggests that individuals struggle to maintain eco-driving behaviours without support. This paper evaluates an in-vehicle visual interface system designed to support eco-driving through recommendations based on both feedforward and feedback information. A simulator study explored participants’ fuel usage, driving style, and cognitive workload driving normally, when eco-driving without assistance and when using a visual interface. Improvements in fuel-efficiency were observed for both assisted (8.5%) and unassisted eco-driving (11%), however unassisted eco-driving also induced a significantly greater rating of self-reported effort. In contrast, using the visual interface did not induce the same increase of reported effort compared to everyday driving, but itself did not differ from unassisted driving. Results hold positive implications for the use of feedforward in-vehicle interfaces to improve fuel efficiency. Accordingly, directions are suggested for future research. **Practitioner Summary:** Results from a simulator study comparing fuel usage from normal driving, engaging in unassisted eco-driving, or using a novel speed advisory interface, designed to reduce fuel use, are presented. Whilst both unassisted and assisted eco-driving reduced fuel use, assisted eco-driving did not induce workload changes, unlike unassisted eco-driving.

- **Keywords:** Fuel use, fuel efficient driving, in-vehicle interface use, eco-driving

Claudio Lantieri, Marco Costa, Valeria Vignali, Ennia Mariapaola Acerra, Pierclaudio Marchetti & Andrea Simone. *Flashing in-curb LEDs and beacons at unsignalized crosswalks and driver’s visual attention to pedestrians during nighttime.* Pages: 330-341.

Driver’s visual attention (eye movements) and driving behaviour (kinematic data) were assessed when approaching an experimental crosswalk that included flashing white in-curb LED strips, flashing orange beacons, backlit ‘Yield here to pedestrians’ vertical signs, and enhanced lighting when a staged pedestrian attempted to cross. An experimental condition in which all devices were active was compared with a control condition in which only enhanced lighting and backlit vertical signs were active. The results showed a significant increase of motorists’ yielding compliance, distance of first fixation to the pedestrian area, standard deviation for horizontal eye movements in the experimental condition. The introduction of flashing in-curb LED strips and flashing orange beacons proved to be very effective in increasing the night-time safety of the pedestrian crossing.

Practitioner summary: The study investigated the effects of flashing in-curb LED strips and beacons on driver's visual attention (eye movements) and speed when approaching a crosswalk during night-time. The results showed that the combination of these flashing devices significantly increased yielding compliance and the distance of pedestrian detection.

- **Keywords:** pedestrian crossing, pedestrian safety, night-time road safety, driver's vision, LED road lighting

Andrew C. Cregg, Ryan C. A. Foley, Lori A. Livingston & Nicholas J. La Delfa. *A biomechanical evaluation of different footrest heights during standing computer work.* Pages: 342-353.

Working at a standing desk is a popular strategy to help reduce low back pain development during prolonged computer work. The purpose of this study was to examine how muscle activity, joint kinematics, weight distribution, balance and low back discomfort were affected by utilising footrests at different heights while working at a standing desk. Sixteen individuals performed a computer task at a standing workstation under four conditions: flat ground stance, and standing with one leg elevated on a low (10 cm), medium (20 cm), or high (30 cm) footrest. Footrest usage altered lumbo-pelvic and bilateral hip joint angles, muscle activity, weight distribution, and range of sway in the elevated limb. Additionally, footrest height altered lumbo-pelvic and hip joint position in the elevated limb. Discomfort increased with time across all conditions. Results suggest that intermittent utilisation of a footrest should be considered to promote changes in posture and muscle activity during prolonged computer use. **Practitioner summary:** This laboratory study showed that utilising a footrest between the heights of 10–30 cm during standing computer work may be beneficial to promote changes in posture and muscle activity over time. However, we recommend exercising caution while maintaining any standing position beyond 10 min of consecutive use.

- **Keywords:** Prolonged standing, ergonomics, footrest height, standing desk, office ergonomics

Luiz Augusto Brusaca, Dechristian França Barbieri, Thomas Beltrame, Juliana Cristina Milan-Mattos, Aparecida Maria Catai & Ana Beatriz Oliveira. *Cardiac autonomic responses to different tasks in office workers with access to a sit-stand table – a study in real work setting.* Pages: 354-365.

The aim of this study was to characterise the cardiac autonomic modulation of different office tasks performed by office workers with access to a sit-stand table. Heart rate variability (HRV) of 24 office workers was measured for two hours during three days in the last week of sit-stand table use. HRV indexes and the percentage of heart rate reserve (%HRR) were calculated during computer and non-computer work tasks while sitting or standing, non-computer tasks away from the work desk, and informal work breaks. All cardiac autonomic responses demonstrated a statistically significant interaction effect between the tasks (all $p < 0.05$) except for the logarithmically-transformed high frequency power (ln HF ms^2 ; $p = 0.14$). Tasks performed while standing and away from the desk had higher sympathetic modulation; in addition, the observed higher %HRR demonstrated that these tasks were more physically demanding in comparison to other tasks. **Practitioner Summary:** Prior reports indicated benefits based on alternated body postures using sit-stand table. Nevertheless, the cardiac autonomic responses of different tasks performed by office workers are unknown. This cross-sectional study showed that different tasks stimulate the cardiac autonomic nervous system in different ways, which could bring positive effects to the cardiovascular system.

- **Keywords:** Heart rate variability, heart rate, office work, sit-stand table, occupational health

Clarisse Gaudes & Marc Mouzé-Amady. *Which subject-related variables contribute to movement variability during a simulated repetitive and standardised occupational task? Recurrence quantification analysis of surface electromyographic signals.* Pages: 366-382.

Movement variability is a component of human movement. This study applied recurrence quantification analysis (RQA) on electromyographic signals to determine the effects of two types of variables on movement variability during a short, simulated repetitive and standardised occupational clip-fitting task. The electrical activity of six muscles in the dominant upper limb was recorded in 21 participants. Variables related to the task performance (insertion force and movements performed when fitting clips) affected RQA measures: recurrence rate (RR), percentage of determinism (DET) and diagonal line length entropy (ENT). Variables related to participant's characteristics (sex, age, and BMI) affected only DET and ENT. A contrasting variability was observed such as a high-DET value combined with a high-ENT value and inversely. Variables affected mainly the recurrences organisation of the more distal muscles. Even if movement variability is complex, it should be considered by ergonomists and work place designers to better understanding of operators' movements. **Practitioner summary:** It is essential to consider the complexity of operators' movement variability to understand their activities. Based on intrinsic movement variability knowledge, ergonomists and work place designers will be able to modulate the movement variability by acting on workstation designs and occupational organisation with the aim of preserving operators' health.

- **Keywords:** Recurrence rate (RR), percentage of determinism (DET), diagonal line length entropy (ENT), clip-fitting taskupper limb

Steven L. Fischer, Sarah Koltun & Jessie Lee. *A cross-sectional survey of musculoskeletal disorder hazard exposures and self-reported discomfort among on-shore wind turbine service technicians.* Pages: 383-395.

Background: Servicing and maintaining wind turbines may expose wind turbine technicians (wind techs) to musculoskeletal disorder (MSD) hazards. We aimed to characterise MSD hazard exposures and identify work elements that should be prioritised for MSD prevention efforts. **Methods:** A cross-sectional online survey methodology gathered data from 144 wind techs based on a convenience, non-probability sampling approach. The survey was developed using resources from the Ontario MSD Prevention Guideline, where cognitive interviewing yielded wind tech specific modifications. **Results:** Climbing was the most physically demanding task, followed by torqueing/tensioning and manual materials handling (MMH). However, working in awkward and constrained postures emerged as the task most likely to cause or aggravate discomfort. **Conclusions:** Injecting ergonomic and human factors principles into wind turbine design should be a high priority. Re-engineering tools like torque tensioning devices may reduce MSD hazard exposures associated with tasks including torqueing/tensioning and MMH. **Practitioner Summary:** We know little about musculoskeletal disorder (MSD) hazards associated with green jobs. By surveying wind turbine technicians, we learned that MSD hazards exists, and can be addressed by better considering human factors/ergonomics principles in the design of wind turbines and the tools required for service and maintenance operations.

- **Keywords:** Green ergonomics, hazard identification, proactive ergonomics, physical ergonomics

Gunter P. Siegmund, Mark G. Blanchette, John R. Brault, Dennis D. Chimich & Benjamin S. Elkin. *Quantifying the uncertainty in tribometer measurements on walkway surfaces*. Pages: 396-409.

Properly estimating and reporting the uncertainty of walkway surface friction is key to ensuring pedestrian safety. Here we quantified the amount and sources of uncertainty in friction measurements by having four users of four units of each of two walkway tribometer models (Slip-Test Mark IIIB, English XL) perform 12 measurements on four samples of four different surfaces that ranged from slippery to slip-resistant. We found that 51–82% of the total variance in the measurements was explained by the user, unit, sample and a user–unit interaction, which means that the variance a single user calculates from their own data does not capture most of the uncertainty in their measurements. Based on these data, the minimum uncertainty associated with the mean of a user's measurements is ± 0.064 (Mark IIIB) and ± 0.072 (XL) to be 95% confident that their mean captures a surface's available friction. **Practitioner Summary:** Walkway surface friction measurements are less accurate than they appear. Based on an experiment quantifying the amount and sources of uncertainty in surface friction measurements using two common tribometers, we quantified and report the minimum uncertainty that users can assign to their walkway surface friction measurements.

- **Keywords:** Slip resistance, variability, available friction, flooringslip and falltribometry

Michelle Norris, Tim Blackmore, Brogan Horler & Joanna Wakefield-Scurr. *How the characteristics of sports bras affect their performance*. Pages: 410-425.

Breast movement reduction (%) measures breast support and sports bra performance, however limited evidence exists on the sports bra characteristics which affect it. This study investigated breast movement reduction achieved by 98 sports bras, the categorisation of support levels, and the characteristics that contribute. Each bra was tested on ~12 females (total $n = 77$). Relative breast position was recorded during sports bra and bare-breasted running, and breast movement reduction calculated; low, medium, high breast support tertiles were identified and compared to brand-classified support levels. Ten bra characteristics were identified, and regressions determined which characteristics contributed to performance. Breast movement reduction ranged from 36% to 74%; 69% of bras marketed as high support were in the high support tertile (>63%). Encapsulation style, padded cups, nylon, adjustable underband and high neck drop accounted for 37.1% of breast movement reduction variance. Findings facilitate high performance sports bra development and inform consumer choice. **Practitioner summary:** Little is known about the biomechanical breast support which sports bras actually provide. This original research facilitates high performance sports bra development, and helps inform consumer choice, by identifying the breast movement reduction of a large sample of sports bras, and the characteristics which impact sports bra performance.

- **Keywords:** Brabreast health, breast support, exercise, running