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Peter Vink, Shabila Anjani, Sumalee Udomboonyanupap, Golnoosh Torkashvand, Thomas Albin, Symone Miguez, Wenhua Li, Christian Reuter & Amalia Vanacore. *Differences and similarities in comfort and discomfort experience in nine countries in Asia, the Americas and Europe*. Pages: 553-570.

In order to investigate differences in comfort and discomfort experiences amongst different regions of the world (America, Asia and Europe), a cross cultural study was performed. A questionnaire was sent to participants out in nine countries (Brazil, Canada, the USA, China, Indonesia, Thailand, Germany, Italy and the Netherlands). In total 795 participants completed the questionnaires. All countries score the comfort of a luxurious bed higher than a simple bed, first-class seats higher than economy class and all countries rate the comfort lower when the duration of sitting increases. The study suggests that in the USA and Canada softer beds, hammocks, more luxurious seats and softer pillows are scored as more comfortable compared with the other countries. There are indications that China and Germany prefer a harder mattress than in the other countries. For pillows, the differences between countries are large, which might show that much is influenced by habitude or hesitation to use something new. The Asian countries score the comfort of a brace neck pillow higher, which might be because these participants better realise the benefits better or feel less concerned to wear something that might give the appearance of an orthotic device. Further studies are needed to confirm these suggestions. The study shows that obvious differences are seen in all countries, which makes the construct of comfort internationally comparable. **Practitioner summary:** In designing and manufacturing globally, it is important to know how different parts of the world experience (dis)comfort. This study did not show large cultural differences amongst nine countries. Some differences emerge regarding pillows, perhaps as differences in sleeping habits play a role.

- **Keywords:** Comfort, discomfort, cross cultural, different countries, sitting, sleeping

Anna Sofie T. Larsen, Kristoffer L. Norheim, Ramtin Z. Marandi, Ernst A. Hansen & Pascal Madeleine. *A field study investigating sensory*

***manifestations in recreational female cyclists using a novel female-specific cycling pad*. Pages: 571-581.**

This randomised controlled field study aimed to design a female-specific cycling pad with reduced padding in the crotch area (half-pad) and test its effects on self-reported sensory manifestations in comparison with full-padded cycling bib shorts. Recreational female road cyclists ($n = 183$) participated (divided into two groups). Self-reported sensory manifestations were collected six times over 12 weeks. Sitting discomfort, wetness perception, thermal, texture sensation, and wear discomfort decreased over time for the crotch and sitting-bones areas in both groups. Irritation and tenderness in the crotch area also decreased over time in both groups. Irritation and tenderness in the sitting-bones area were only higher at week two in the half-pad compared with the full-pad group. Cycling with the half-padded shorts compared with the full-padded ones had no negative effects on sensory manifestations beside the observed transient change at week two. This suggests that foam thickness in the crotch area can be reduced in female-specific cycling pads. **Practitioner's Summary:** Road cycling might result in discomfort and non-traumatic injuries in the female genital area. This field study compares two different cycling pads; a half-pad and a full-pad, over a 12-week period among female recreational road cyclists. Reducing the foam thickness in the crotch area of the pad does not change sensory manifestations, i.e. discomfort, wetness perception, texture-, and thermal-sensation as well as wear discomfort.

- **Keywords:** Bib shorts, discomfort, ergonomics intervention, crotch, road cycling

Maureen F. Riddell & Jack P. Callaghan. *Ergonomics training coupled with new Sit-Stand workstation implementation influences usage*. Pages: 582-592.

Currently, there is no guidance on the training programme approach that should be provided to new sit-stand workstation users to optimally integrate workstation usage patterns into their working day. The objective of this research study was to determine if a training programme could influence long-term usage of sit-stand workstations. Thirty-five employees from the University of Waterloo volunteered to participate in this longitudinal study. Two different types of training programmes were delivered: (1) an example from industry and (2) based on current literature. There was an influence of training programme on the frequency of sit to stand transitions made each day. Those who received the additional training programme also reported sitting less, standing more and used their sit-stand workstations more consistently day-to-day than those who did not. **Practitioner Summary:** A longitudinal study was conducted to assess the impact of training programmes on sit-stand workstation usage. A training programme based on current literature resulted in more consistent sit-stand usage than an industry example.

- **Keywords:** Musculoskeletal symptoms, physical ergonomics, training, office ergonomics

Fatema Gheewalla, Alastair McClelland & Adrian Furnham. *Effects of background noise and extraversion on reading comprehension performance*. Pages: 593-599.

This study was concerned with the effects of acoustic distraction at work. Using a within-subject study we aimed to investigate the effect of background distraction on cognitive performance. In the presence of silence, white noise, and sirens, 55 fluent English speakers completed three equivalent variations of a reading comprehension task. As predicted, there was a significant main effect of background sound, with poorer performance in the presence of distraction (particularly sirens), but no interaction was found between distraction and extraversion. Thus, the findings partially replicated

previous research in terms of distraction but were inconsistent with regard to the Eysenckian theory of arousal differences between introverts and extraverts. Implications of the effect of sirens on those they are not designed to alert are considered. Limitations of this study are also considered. **Practitioner Summary:** This study was concerned with whether white noise and the sound of sirens affects reading comprehension. We found that compared to doing a highly involving and demanding cognitive task in silence, siren noise has the most significant negative effect on performance. Compared to working silence, white noise also reduced the efficiency of text comprehension. There were no introvert–extravert effects.

- **Keywords:** Extraversion, personality, distraction, cognitive performance, background noise

Swapnali Karvekar, Masoud Abdollahi & Ehsan Rashedi. *Smartphone-based human fatigue level detection using machine learning approaches*. Pages: 600-612.

Human muscle fatigue is the main result of diminishing muscle capability, leading to reduced performance and increased risk of falls and injury. This study provides a classification model to identify the human fatigue level based on the motion signals collected by a smartphone. 24 participants were recruited and performed the fatiguing exercise (i.e. squatting). Upon completing each set of squatting, they walked for a fixed distance while the smartphone attached to their right shank and the gait data were associated with the Borg's Rating of Perceived Exertion (i.e. data label). Our machine-learning model of two (no- vs. strong-fatigue), three (no-, medium-, and strong-fatigue) and four (no-, low-, medium-, and strong-fatigue) levels of fatigue reached the accuracy of 91, 78, and 64%, respectively. The outcomes of this study may facilitate the accessibility of a fatigue-monitoring tool in the workplace, which improves the workers' performance and reduce the risk of falls and injury. **Practitioner Summary:** This study aimed to develop a machine-learning model to identify human fatigue level using motion data captured by a smartphone attached to the shank. Our results can facilitate the development of an accessible fatigue-monitoring system that may improve the workers' performance and reduce the risk of falls and injury.

- **Keywords:** Wearable technology, human muscle fatigue, machine learning, smartphone, support vector machine

Yaar Harari, Raziel Riemer & Avital Bechar. *Shoulder moments and angles during single and combined manual material handling tasks*. Pages: 613-624.

Shoulder musculoskeletal disorders due to manual material handling tasks are common workplace injuries. Here we investigated the difference in shoulder biomechanics (moments and angles) between a single task of removing a box from a shelf (or depositing a box on a shelf) and the equivalent part of a combined task that consisted of removing, carrying and depositing boxes; that is, a single *removing* [*depositing*] task was compared with the *removing* [*depositing*] part of a combined task. We found that the peak and cumulative shoulder moments were larger during the single-task paradigm than during the equivalent part of the combined task by 26.3 and 25.5%, respectively. The two paradigms also differed in terms of shoulder angles. It is likely that the main contributors to this overestimation were differences between the single and combined tasks in terms of the lever arm (i.e. horizontal distance), the shoulder angle, and the task duration. **Practitioners' Summary:** We investigated shoulder moments during single and combined manual material handling tasks. Shoulder moments were found to be smaller during combined tasks. Practitioners should consider that analysing combined tasks using estimations based on single tasks could result in an overestimation of 26.3 and 25.5% in peak and cumulative shoulder moments, respectively.

- **Keywords:** Shoulder moment, shoulder angle, manual material handling, shoulder injury, musculoskeletal disorders

Urša Ciuha, Tamara Valenčič & Igor B. Mekjavic. *Cooling efficiency of vests with different cooling concepts over 8-hour trials*. Pages: 625-639.

As frequency and severity of heat waves are increasing, personal cooling systems are being considered as a tool to mitigate heat strain in workers in various occupational settings. This study assessed cooling capacities (C; $W \cdot h \cdot m^{-2}$) of various commercially available vests using different cooling concepts. Measurements were conducted over 8 h in a climatic chamber (Ta: 35 °C, RH: 35 %) using a thermal manikin (Ts: 35 °C). Cooling power (P) and duration of efficient cooling (t_c) determined the C value of each vest. Among the cooling concepts the active cooling vests were the most efficient, extracting 331 $W \cdot h \cdot m^{-2}$, followed by the vests with phase change material (PCM) inserts, hybrid and evaporative vests, extracting a maximum of 164 $W \cdot h \cdot m^{-2}$, 146 $W \cdot h \cdot m^{-2}$ and 113 $W \cdot h \cdot m^{-2}$, respectively. While some vests with PCM inserts provided intense but shorter cooling, evaporative vests provided mild but longer cooling throughout. **Practitioner summary:** The study assessed the cooling capacity of commercially available vests, using a thermal manikin. The vests present an affordable solution in various occupational settings where air-conditioning is not an option. A range of cooling capacities among different cooling concepts and vests of the same category were noted.

- **Keywords:** Cooling vests, Evaluation, cooling capacity, thermal manikin, industry workers

Hao Fan, Suihuai Yu, Mengcheng Wang, Mei Li, Jianjie Chu, Yishu Yan, Shuai Zhang, Dengkai Chen & Carisa Harris-Adamson. *Analysis of the external acoustic meatus for ergonomic design: part I – measurement of the external acoustic meatus using casting, scanning and rapid estimation approaches*. Pages: 640-656.

Numerous ear-related wearables require precise measurements of the external acoustic meatus (EAM) to optimise function and comfort. The purpose of this study is to describe a novel methodology for measuring the EAM. A total of 23 measurement variables (18 novel) of the EAM from the entrance to the second bend were collected on 700 Chinese subjects (age: 15–83) using casting and 3D scanning over seven age spans: 10, 20, 30, 40, 50, 60 s and 70+. The ear horizontal plane was identified as a new reference plane for measurements and the medial concha was selected as the reference point for positioning the entrance. A detailed approach to characterising the EAM was developed as was an approach for the rapid estimation of circumference and area using regression equations making it ideal for use in early design conceptualizations. **Practitioner summary:** This study provides a scalable measurement methodology for determining anthropometric measurements of the external acoustic meatus. The measurement methodology and its application to the design and fitting of ear-related wearables are important to optimising their function and comfort.

- **Keywords:** External acoustic meatus, ear-related wearables, 3D anthropometry, ergonomic design

Hao Fan, Suihuai Yu, Mengcheng Wang, Mei Li, Xiao Zhao, Yihui Ren, Shuai Zhang, Dengkai Chen & Carisa Harris Adamson. *Analysis of the external acoustic meatus for ergonomic design: part II – anthropometric variations of the external acoustic meatus by sex, age and side in Chinese population*. Pages: 657-670.

For devices worn inside the ear, detailed anthropometric data of the external acoustic meatus (EAM) is needed, yet lacking due to the complex and costly methodology associated with attaining such measurements. The purpose of this study was to provide the anthropometric characteristics of the EAM including variations by age group, sex, and side (right/left). 1400 external ears (700 Chinese subjects) were casted and scanned. A total of 23 EAM dimensions of length, width, angle, circumference and area were measured, most of which changed by age group, sex and side. 19 measurements were larger in males and 17 measurements were larger in left-side ears. Except the entrance length and circumference, measurements were not statistically significant between left- and right-side ears. This study provides key anthropometric measurements of the EAM in a Chinese population which can be used for ergonomic design purposes. **Practitioner summary:** This study provides an available source for anthropometric variations of the external acoustic meatus by age, gender and side in the Chinese population, which can be used as a reference to improve the fit, comfort and function of in-ear wearable devices.

- **Keywords:** External acoustic meatus, anthropometric characteristics, growth trajectory, in-ear wearables, ergonomic design

Sara Könings, Susanne Mayr & Axel Buchner. *LED-based light sources optimised for high colour rendition from an end users' perspective*. Pages: 671-683.

Light emitting diode (LED) technology is continuously developing, leading to the current transition from simple phosphor-converted LED lamps to LED lamps optimised for high colour rendition in residential lighting. To assess whether such optimised phosphor-converted LED lamps may fulfil the end users' needs better than simple phosphor-converted LED lamps we asked participants to rank two particular brands of phosphor-converted LED lamps optimised for high colour rendition, a typical simple phosphor-converted LED lamp and a halogen lamp for pleasantness, naturalness and purchase preference. The results of two experiments suggest that phosphor-converted LED lamps optimised for high colour rendition have the potential to outperform simple phosphor-converted LED lamps and even to measure up to traditional halogen lighting in terms of user preference. However, this is not the case for all phosphor-converted LED lamps optimised for high colour rendition. From the end users' perspective, unfortunately, it is currently difficult if not impossible to choose the LED light source that one would prefer most. **Practitioner Summary**: Considering innovations in LED technology, we assessed the potential of LED lamps optimised for high colour rendition to outperform their predecessors regarding user preference. In one of two conditions, these optimised LED lamps outperformed a simple phosphor-converted LED lamp and measured up to halogen lighting.

- **Keywords:** Phosphor-converted LED, halogen lamp, preference, naturalness, end user acceptance