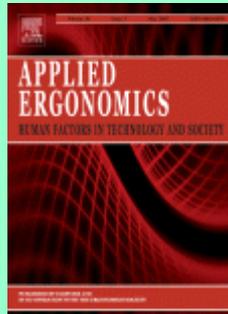


## **Applied Ergonomics - rok 2015, ročník 46**

### **Číslo 1 – Part A (January 2015)**



#### ***Wen-Zhou Shi, Fong-Gong Wu. An investigation of the performance of novel chorded keyboards in combination with pointing input devices.***

Rapid advances in computing power have driven the development of smaller and lighter technology products, with novel input devices constantly being produced in response to new user behaviors and usage contexts. The aim of this research was to investigate the feasibility of operating chorded keyboard control modules in concert with pointing devices such as styluses and mice. We compared combinations of two novel chorded keyboards with different pointing devices in hopes of finding a better combination for future electronic products. Twelve participants were recruited for simulation testing, and paired sample t testing was conducted to determine whether input and error rates for the novel keyboards were improved significantly over those of traditional input methods. The most efficient input device combination tested was the combination of a novel cross-shaped key keyboard and a stylus, suggesting the high potential for use of this combination with future mobile IT products.

- **Keywords:** Chorded keyboard; Pointing input; Operating efficiency

#### ***Sandrine Fischer, Makoto Itoh, Toshiyuki Inagaki. Prior schemata transfer as an account for assessing the intuitive use of new technology.***

New devices are considered intuitive when they allow users to transfer prior knowledge. Drawing upon fundamental psychology experiments that distinguish prior knowledge transfer from new schema induction, a procedure was specified for assessing intuitive use. This procedure was tested with 31 participants who, prior to using an on-board computer prototype, studied its screenshots in reading vs. schema induction conditions. Distinct patterns of transfer or induction resulted for features of the prototype whose functions were familiar or unfamiliar, respectively. Though moderated by participants' cognitive style, these findings demonstrated a means for quantitatively assessing transfer of prior knowledge as the operation that underlies intuitive use. Implications for interface evaluation and design, as well as potential improvements to the procedure, are discussed.

- **Keywords:** Intuitive use; Schemata theory; Transfer

#### ***V. Boccara, C. Vidal-Gomel, J. Rogalski, P. Delhomme. A longitudinal study of driving instructor guidance from an activity-oriented perspective.***

The aim of this study was to provide a better understanding of the scaffolding activity of instructors during driving lessons in a French urban traffic context. It focuses on three common and risky tasks: turning right, turning left and overtaking. Data were based on fine-grained longitudinal analyses of the records of five driving lessons involving four student-instructor dyads. The instructor scaffolding activity was analyzed throughout training – an original approach in the sphere of driving. The results show that the instructors implemented the learning process using an integrative approach based on 'cutting' and 'decoupling' the driving task rather than the step-by-step method recommended in the curriculum. They transferred the responsibility of the driving components to the students in a similar order: 1) technical maneuvers, 2) situation identification and 3) goals focusing on other road-users. As expected, student autonomy and efficiency in driving increased as the training progressed. However, at the end of training, uncertainties remained with regard to the execution of basic sub-goals in complex situation; moreover, the instructors were still in charge of the navigational task. The results were discussed and suggestions were made to improve instructor training with a view to increasing their efficiency in teaching students.

- **Keywords:** Ergonomics; Driving; Training

**Matthew Lee Smith, Adam W. Pickens, SangNam Ahn, Marcia G. Ory, David M. DeJoy, Kristi Young, Gary Bishop, Jerome J. Congleton. *Typing performance and body discomfort among overweight and obese office workers : a pilot study of keyboard modification.***

Obesity in the workplace is associated with loss of productivity, high medical care expenses, and increased rates of work-related injuries and illness. Thus, effective, low-cost interventions are needed to accommodate the size of today's obese office worker while alleviating potential physical harm associated with musculoskeletal disorders. Utilizing a sample of 22 overweight and obese office workers, this pilot study assessed the impact of introducing an alternative, more ergonomically-sound keyboard on perceptions about design, acceptability, and usability; self-reported body discomfort; and typing productivity. Data were collected using self-reported questionnaires and objective typing tests administered before and after the intervention. The intervention duration was six weeks. After switching from their standard work keyboard to an alternative keyboard, all participants reported significant decreases in lower back discomfort ( $t = 2.14$ ,  $P = 0.044$ ); although obese participants reported significant decreases in both upper ( $t = 2.46$ ,  $P = 0.032$ ) and lower ( $t = 2.39$ ,  $P = 0.036$ ) back discomfort. No significant changes were observed in overall typing performance scores from baseline to follow-up. Findings suggest that such interventions may be introduced into the workforce with positive gains for workers without reducing short-term worker productivity.

- **Keywords:** Obesity; Body discomfort; Keyboard ergonomics

**Xingda Qu. *Impacts of different types of insoles on postural stability in older adults.***

The objective of this study was to examine the effects of different types of insoles on postural stability in older adults. Four types of commercially available insoles were selected including the cupped insoles, textured insoles, rigid insoles, and soft insoles. The experiment included a static stance session and a walking session. In the static stance session, the participants stood upright on a force platform as still as possible, with feet together, arms by the side and looking straight ahead. The mean velocity of center-of-pressure time series obtained from the force platform was used to assess static postural stability. In the walking session, the participants walked on a treadmill at their self-selected comfortable speed for 4.5 min in each insole condition. Dynamic postural stability was assessed using the margin of stability. It was found that static postural stability was not affected by insoles, but cupped insoles improved dynamic postural

stability, and rigid insole was associated with better dynamic postural stability compared to soft insoles. These findings can aid in better understanding the insole design features associated with improved postural stability in older adults.

- **Keywords:** Insole interventions; Postural stability; Falls in older adults

**Chuansi Gao, Li-Yen Lin, Amitava Halder, Kaleb Kuklane, Ingvar Holmér. *Validation of standard ASTM F2732 and comparison with ISO 11079 with respect to comfort temperature ratings for cold protective clothing.***

American standard ASTM F2732 estimates the lowest environmental temperature for thermal comfort for cold weather protective clothing. International standard ISO 11079 serves the same purpose but expresses cold stress in terms of required clothing insulation for a given cold climate. The objective of this study was to validate and compare the temperature ratings using human subject tests at two levels of metabolic rates (2 and 4 MET corresponding to 116.4 and 232.8 W/m<sup>2</sup>). Nine young and healthy male subjects participated in the cold exposure at 3.4 and -30.6 °C. The results showed that both standards predict similar temperature ratings for an intrinsic clothing insulation of 1.89 clo and for 2 MET activity. The predicted temperature rating for 2 MET activity is consistent with test subjects' thermophysiological responses, perceived thermal sensation and thermal comfort. For 4 MET activity, however, the whole body responses were on the cold side, particularly the responses of the extremities. ASTM F2732 is also limited due to its omission and simplification of three climatic variables (air velocity, radiant temperature and relative humidity) and exposure time in the cold which are of practical importance.

- **Keywords:** Cold; protective clothing; Metabolic rate; Thermal comfort

**Veronika Leichtfried, Maria Mair-Raggautz, Viktoria Schaeffer, Angelika Hammerer-Lercher, Gerald Mair, Christian Bartenbach, Markus Canazei, Wolfgang Schobersberger. *Intense illumination in the morning hours improved mood and alertness but not mental performance.***

Cognitive performance and alertness are two determinants for work efficiency, varying throughout the day and depending on bright light. We conducted a prospective crossover study evaluating the impacts of exposure to an intense, early morning illumination on sustained attention, alertness, mood, and serum melatonin levels in 33 healthy individuals. Compared with a dim illumination, the intense illumination negatively impacted performance requiring sustained attention; however, it positively impacted subjective alertness and mood and had no impact on serum melatonin levels. These results suggest that brief exposure to bright light in the morning hours can improve subjective measures of mood and alertness, but can also have detrimental effects on mental performance as a result of visual distraction. Therefore, it is important that adequate lighting should correspond to both non-visual and visual demands.

- **Keywords:** Sustained attention; Bright light exposure; Melatonin

**Joseph M. Mahoney, Nicolas A. Kurczewski, Erick W. Froede. *Design method for multi-user workstations utilizing anthropometry and preference data.***

Past efforts have been made to design single-user workstations to accommodate users' anthropometric and preference distributions. However, there is a lack of methods for designing workstations for group interaction. This paper introduces a method for sizing workstations to allow for a personal work area for each user and a shared space for adjacent users. We first create a virtual population with the same anthropometric and

preference distributions as an intended demographic of college-aged students. Members of the virtual population are randomly paired to test if their extended reaches overlap but their normal reaches do not. This process is repeated in a Monte Carlo simulation to estimate the total percentage of groups in the population that will be accommodated for a workstation size. We apply our method to two test cases: in the first, we size polygonal workstations for two populations and, in the second, we dimension circular workstations for different group sizes.

- **Keywords:** Workstation design parameters; Group interaction; Engineering anthropometry

**Ayubkhon Radjiyev, Hai Qiu, Shuping Xiong, KyungHyun Nam. *Ergonomics and sustainable development in the past two decades (1992–2011) : research trends and how ergonomics can contribute to sustainable development.***

The need for sustainable development has been widely recognized and sustainable development has become a hot topic of various disciplines even though the role of ergonomics in it is seldom reported or considered. This study conducts a systematic survey of research publications in the fields of ergonomics and sustainable development over the past two decades (1992–2011), in order to identify their research trends and convergent areas where ergonomics can play an important role in sustainable development. The results show that 'methods and techniques', 'human characteristics', 'work design and organization', 'health and safety' and 'workplace and equipment design' are the top five frequently researched areas in ergonomics. Ergonomics has an opportunity to contribute its knowledge especially to 'industrial and product design', 'architecture', 'health and safety' and 'HCI' (especially for energy reduction issues) categories of sustainable development. Typical methodologies and general guidance on how to contribute the expertise of ergonomist to sustainable development are also discussed.

- **Keywords:** Ergonomics; Sustainable development; Literature survey

**Sol Hee Yoon, Jihyoun Lim, Yong Gu Ji. *Assessment model for perceived visual complexity of automotive instrument cluster.***

This research proposes an assessment model for quantifying the perceived visual complexity (PVC) of an in-vehicle instrument cluster. An initial study was conducted to investigate the possibility of evaluating the PVC of an in-vehicle instrument cluster by estimating and analyzing the complexity of its individual components. However, this approach was only partially successful, because it did not take into account the combination of the different components with random levels of complexity to form one visual display. Therefore, a second study was conducted focusing on the effect of combining the different components. The results from the overall research enabled us to suggest a basis for quantifying the PVC of an in-vehicle instrument cluster based both on the PVCs of its components and on the integration effect.

- **Keywords:** Perceived visual complexity; Quantifiable measurement variables; Assessment model

**Neal Wiggermann, W. Monroe Keyserling. *Time to onset of pain : effects of magnitude and location for static pressures applied to the plantar foot.***

Mechanisms that cause foot discomfort during prolonged standing are poorly understood. There is currently no method for evaluating discomfort associated with low levels of static

pressure that are typical during standing. Pain thresholds were measured for 20 healthy participants by applying five levels of static pressure at different plantar foot locations. A survival analysis was performed to determine the effects of pressure magnitude and foot location on the time until pain onset. Time to pain onset was significantly affected by pressure magnitude ( $P < 0.001$ ); time decreased as pressure increased. Foot location was also significant ( $P < 0.001$ ); greatest times to pain onset (least sensitive) were observed under the heel and fifth metatarsal head, shortest times (most sensitive) were found under the midfoot. This research presents a novel methodology for evaluating static pressure that may be applicable to product design.

- **Keywords:** Standing; Pain-pressure threshold; Sensory testing

**Ranjana K. Mehta, Lora A. Cavuoto. *The effects of obesity, age, and relative workload levels on handgrip endurance.***

The purpose of the study was to examine obesity and age effects on handgrip endurance across a range of relative workload levels. Forty-five non-obese and obese younger and older females performed fatiguing handgrip exercises at 20, 40, 60, and 80% of relative handgrip strength. The younger obese group demonstrated ~7% greater strength, 32% shorter endurance times, and ~34% faster rate of strength loss, accompanied by heightened perception of effort, than the younger non-obese group. However, these obesity-related differences were not observed in the older age group. Moreover, there were no interactions between relative workload levels, obesity, and age on any of the fatigue measures. Findings obtained here suggest that work-rest schedules computed from existing force endurance prediction models may not be protective of the younger obese working population.

- **Keywords:** BMI; Fatigue; Aging

**Jay P. Mehta, Steven A. Lavender, Glenn E. Hedman, Paul A. Reichelt, Sanghyun Park, Karen M. Conrad. *Evaluating the physical demands on firefighters using track-type stair descent devices to evacuate mobility-limited occupants from high-rise buildings.***

The physical demands on firefighting personnel were investigated when using different types of track-type stair descent devices designed for the emergency evacuation of high rise buildings as a function of staircase width and evacuation urgency. Twelve firefighters used five track-type stair descent devices during simulated urgent and non-urgent evacuations. The devices were evaluated under two staircase width conditions (1.12, and 1.32 m), and three devices were also evaluated under a narrower staircase condition (0.91 m). Dependent measures included electromyographic (EMG) data, spine motion, heart rates, Borg Scale ratings, task durations and descent velocities. Stair descent speeds favored the devices that had shorter fore/aft dimensions when moving through the landing. EMG results indicated that there were tradeoffs due to design features, particularly on the landings where the physical demands tended to be greater. On the landings, devices that could be rolled on four wheels reduced the deltoid and bicep activation levels.

- **Keywords:** Firefighter/EMS; Stair descent devices; Evacuation of individuals with disabilities

**Raoni Rocha, Vanina Mollo, François Daniellou. *Work debate spaces : a tool for developing a participatory safety management.***

In recent years, various studies have shown the importance of instituting work debate space within companies in order to address constraints within the organization. However,

few of these studies demonstrate the implementation methods of discussion spaces and their contributions. Based on the action research developed in an electric company, this article demonstrates how work debate space (WDS) contribute to the development of an integrated safety culture. After describing the establishment methods and function of WDS within a technical group, we will present the main benefits of these spaces for the organization and its employees, and then discuss the minimal conditions for their implementation.

- **Keywords:** Managed safety; Reflective practices; Work debate space

**Anping Xie, Pascale Carayon, Randi Cartmill, Yaqiong Li, Elizabeth D. Cox, Julie A. Plotkin, Michelle M. Kelly. *Multi-stakeholder collaboration in the redesign of family-centered rounds proces.***

A human factors approach to healthcare system redesign emphasizes the involvement of multiple healthcare stakeholders (e.g., patients and families, healthcare providers) in the redesign process. This study explores the experience of multiple stakeholders with collaboration in a healthcare system redesign project. Interviews were conducted with ten stakeholder representatives who participated in the redesign of the family-centered rounds process in a pediatric hospital. Qualitative interview data were analyzed using a phenomenological approach. A model of collaborative healthcare system redesign was developed, which defined four phases (i.e., setup of the redesign team, preparation for meetings, collaboration in meetings, follow-up after meetings) and two outcomes (i.e., team outcomes, redesign outcomes) of the collaborative process. Challenges to multi-stakeholder collaboration in healthcare system redesign, such as need to represent all relevant stakeholders, scheduling of meetings and managing different perspectives, were identified.

- **Keywords:** Multi-stakeholder collaboration; Healthcare system redesign; Family-centered rounds

**F.S. Ayachi, J. Dorey, C. Guastavino. *Identifying factors of bicycle comfort : an online survey with enthusiast cyclists.***

Racing bicycles have evolved significantly over the past decades as technology and cyclists' comfort have become a critical design issue. Although ample research has been conducted on comfort for other means of transportation, cyclists' perception of dynamic comfort has received scant attention in the scientific literature. The present study investigates how enthusiast cyclists conceptualize comfort using an online survey with 244 respondents. The purpose is to determine which factors contribute to comfort when riding a bicycle, to identify situations in which comfort is relevant and to determine the extent to which vibrations play a role in comfort evaluations. We found that comfort is influenced by factors related to bicycle components (specifically the frame, saddle and handlebar), as well as environmental factors (type or road, weather conditions) and factors related to the cyclist (position, adjustments, body parts). Respondents indicated that comfort is a concern when riding a bicycle in most situations and they believed that comfort is compatible with performance. The PCA analysis shows that for the perception "human factor-body parts" are put in evidence, and the "cyclist's comfort" evaluation is mainly based on certain qualities related to the bicycle components, then the road and external conditions (e.g. weather, temperature).

- **Keywords:** Comfort & human perception; Cyclists; Multidimensional statistics analysis

**Ollie Jay, Matthew N. Cramer, Nicholas M. Ravanelli, Simon G. Hodder. *Should electric fans be used during a heat wave?***

Heat waves continue to claim lives, with the elderly and poor at greatest risk. A simple and cost-effective intervention is an electric fan, but public health agencies warn against their use despite no evidence refuting their efficacy in heat waves. A conceptual human heat balance model can be used to estimate the evaporative requirement for heat balance, the potential for evaporative heat loss from the skin, and the predicted sweat rate, with and without an electrical fan during heat wave conditions. Using criteria defined by the literature, it is clear that fans increase the predicted critical environmental limits for both the physiological compensation of endogenous/exogenous heat, and the onset of cardiovascular strain by an air temperature of ~3–4 °C, irrespective of relative humidity (RH) for the young and elderly. Even above these critical limits, fans would apparently still provide marginal benefits at air temperatures as high as 51.1 °C at 10%RH for young adults and 48.1 °C at 10%RH for the elderly. Previous concerns that dehydration would be exacerbated with fan use do not seem likely, except under very hot (>40 °C) and dry (<10%RH) conditions, when predicted sweat losses are only greater with fans by a minor amount (~20–30 mL/h). Relative to the peak outdoor environmental conditions reported during ten of the most severe heat waves in recent history, fan use would be advisable in all of these situations, even when reducing the predicted maximum sweat output for the elderly. The protective benefit of fans appears to be underestimated by current guidelines.

- **Keywords:** Extreme heat events; Hydration; Air flow

**Setia Hermawati, Glyn Lawson, Mirabelle D'Cruz, Frank Arlt, Judith Apold, Lina Andersson, Maria Gink Lövgren, Lennart Malmsköld.**  
***Understanding the complex needs of automotive training at final assembly lines.***

Automobile final assembly operators must be highly skilled to succeed in a low automation environment where multiple variants must be assembled in quick succession. This paper presents formal user studies conducted at OPEL and VOLVO Group to identify assembly training needs and a subset of requirements; and to explore potential features of a hypothetical game-based virtual training system. Stakeholder analysis, timeline analysis, link analysis, Hierarchical Task Analysis and thematic content analysis were used to analyse the results of interviews with various stakeholders (17 and 28 participants at OPEL and VOLVO, respectively). The results show that there is a strong case for the implementation of virtual training for assembly tasks. However, it was also revealed that stakeholders would prefer to use a virtual training to complement, rather than replace, training on pre-series vehicles.

- **Keywords:** Assembly; Virtual; Training

**Baiduri Widanarko, Stephen Legg, Jason Devereux, Mark Stevenson.**  
***Interaction between physical and psychosocial work risk factors for low back symptoms and its consequences amongst Indonesian coal mining workers.***

This study assessed the interaction between physical and psychosocial factors for low back symptoms (LBS) and its consequences (reduced activities and absenteeism) in a developing country. A sample of 1294 Indonesian coal mining workers reported occupational exposures, LBS and its consequences using a self-administered questionnaire. Respondents were placed into one of four combination exposure groups: high physical and high psychosocial (HPhyHPsy); high physical and low psychosocial (HPhyLPsy); low physical and high psychosocial (LPhyHPsy), and; low physical and low psychosocial (LPhyLPsy). The attributable proportion due to interaction between physical and psychosocial factors was examined. Individuals in the HPhyHPsy group were most likely to report LBS (OR 5.42, 95% CI 3.30–8.89), reduced activities (OR 4.89, 95% CI

3.09–7.74), and absenteeism (OR 4.96, 95% CI 3.05–8.06). Interactions between physical and psychosocial factors were present for LBS, reduced activities, and absenteeism; although for LBS and absenteeism the interactions were not significant. Current smokers were more likely to report LBS consequences. Permanent employment and night shift work increased the odds of LBS and its consequences. We conclude that interventions aimed at reducing LBS and its consequences should address both physical and psychosocial factors, with a focus on smokers, permanent employment and night shift work.

- **Keywords:** Developing country; Musculoskeletal disorders; Work stress

**Kari L. Loverro, Tyler N. Brown, Megan E. Coyne, Jeffrey M. Schiffman. *Use of body armor protection with fighting load impacts soldier performance and kinematics.***

The purpose of this evaluation was to examine how increasing body armor protection with and without a fighting load impacted soldiers' performance and mobility. Thirteen male soldiers performed one performance (repeated 30-m rushing) and three mobility tasks (walk, walk over and walk under) with three different body armor configurations and an anterior fighting load. Increasing body armor protection, decreased soldier performance, as individual and total 30-m rush times were significantly longer with greater protection. While increasing body armor protection had no impact on mobility, i.e. significant effect on trunk and lower limb biomechanics, during the walk and walk over tasks, greater protection did significantly decrease maximum trunk flexion during the walk under task. Adding fighting load may negatively impact soldier mobility, as greater maximum trunk extension was evident during the walk and walk over tasks, and decreased maximum trunk flexion exhibited during the walk under task with the fighting load.

- **Keywords:** Torso load; Gait; Obstacle negotiation

**Susanne Schmidt, Wolfgang Seiberl, Ansgar Schwirtz. *Influence of different shoulder-elbow configurations on steering precision and steering velocity in automotive context.***

Ergonomic design requirements are needed to develop optimum vehicle interfaces for the driver. The majority of the current specifications consider only anthropometric conditions and subjective evaluations of comfort. This paper examines specific biomechanical aspects to improve the current ergonomic requirements. Therefore, a research which involved 40 subjects was carried out to obtain more knowledge in the field of steering movement while driving a car. Five different shoulder-elbow joint configurations were analyzed using a driving simulator to find optimum posture for driving in respect of steering precision and steering velocity. Therefore, a 20 s precision test and a test to assess maximum steering velocity over a range of 90° steering motion have been conducted. The results show that driving precision, as well as maximum steering velocity, are significantly increased in mid-positions (elbow angles of 95° and 120°) compared to more flexed (70°) or extended (145° and 160°) postures. We conclude that driver safety can be enhanced by implementing these data in the automotive design process because faster and highly precise steering can be important during evasive actions and in accident situations. In addition, subjective comfort rating, analyzed with questionnaires, confirmed experimental results.

- **Keywords:** Optimum driving posture; Steering precision; Steering velocity

**Grega Jakus, Christina Dicke, Jaka Sodnik. *A user study of auditory, head-up and multi-modal displays in vehicles.***

This paper describes a user study on the interaction with an in-vehicle information system (IVIS). The motivation for conducting this research was to investigate the subjectively and objectively measured impact of using a single- or multi-modal IVIS while driving. A hierarchical, list-based menu was presented using a windshield projection (head-up display), auditory display and a combination of both interfaces. The users were asked to navigate a vehicle in a driving simulator and simultaneously perform a set of tasks of varying complexity. The experiment showed that the interaction with visual and audio-visual head-up displays is faster and more efficient than with the audio-only display. All the interfaces had a similar impact on the overall driving performance. There was no significant difference between the visual only and audio-visual displays in terms of their efficiency and safety; however, the majority of test subjects clearly preferred to use the multi-modal interface while driving.

- **Keywords:** Auditory display; Head-up display; Vehicle

**Stephanie J. Crowley, Thomas A. Molina, Helen J. Burgess. *A week in the life of full-time office workers : work day and weekend light exposure in summer and winter.***

Little is known about the light exposure in full-time office workers, who spend much of their workdays indoors. We examined the 24-h light exposure patterns of 14 full-time office workers during a week in summer, and assessed their dim light melatonin onset (DLMO, a marker of circadian timing) at the end of the working week. Six workers repeated the study in winter. Season had little impact on the workers' schedules, as the timing of sleep, commute, and work did not vary by more than 30 min in the summer and winter. In both seasons, workers received significantly more morning light on workdays than weekends, due to earlier wake times and the morning commute. Evening light in the two hours before bedtime was consistently dim. The timing of the DLMO did not vary between season, and by the end of the working week, the workers slept at a normal circadian phase.

- **Keywords:** Circadian; Light exposure; Full-time office worker

**H.I. Castellucci, P.M. Arezes, J.F.M. Molenbroek. *Analysis of the most relevant anthropometric dimensions for school furniture selection based on a study with students from one Chilean region.***

Most of the worldwide standards used for furniture selection suggest the use of the Stature of the school children, assuming that all the other anthropometric characteristics will also be appropriate. However, it is important to consider that students' growth differ with age. The aim of this study is to determine if Popliteal Height can be used as a better, or more adequate, measure for classroom furniture selection when comparing with Stature. This study involved a representative group of 3046 students from the Valparaíso Region, in Chile. Regarding the methodology, eight anthropometric measures were gathered, as well as six furniture dimensions from the Chilean standard. After assigning the level of school furniture using Stature and Popliteal Height to each of the students, six mismatch equations were applied. The results show that when using Popliteal Height, higher levels of match were obtained for the two more important furniture dimensions. Additionally, it also presents a better cumulative fit than Stature. In conclusion, it seems that Popliteal Height can be the most accurate anthropometric measure for classroom furniture selection purposes.

- **Keywords:** School furniture; Anthropometry; Mismatch measures

**Wen-Ko Chiou, Hsin-Tzu Chiu, An-Shine Chao, Ming-Hsu Wang, Yi-Lang Chen. *The influence of body mass on foot dimensions during pregnancy.***

In this study, a time-series approach was used to measure women's feet to accurately analyze changes in foot size and body mass during pregnancy. One-hundred women who were pregnant for the first time were asked to respond to questions on subjective complaints of foot discomfort listed in a questionnaire. Among these 100 women, a sample of 30 was obtained and used to measure the women's feet from the twentieth week of the gestation period until labor. The data (from 5 of the 30 women) were used to establish a prediction model for the influence of body mass on changes in foot size during pregnancy. The results indicate that the women subjectively complained that their shoes were too tight, resulting in foot discomfort. From the twentieth to the thirty-eighth week of pregnancy, the average increase in foot length, width, and back foot surface was 0.86 cm (3.6%), 0.25 cm (2.6%), and 18.36 cm<sup>2</sup> (11.9%), respectively. The height of the arch decreased by an average of 0.52 cm (-24.2%). Body mass accounted for more than 90% of the variation (R<sup>2</sup>) in foot dimensions during pregnancy and, thus indicated satisfactory predictive ability. The prediction model developed in this study can serve as a reference for clinical applications and shoe design to prevent women from experiencing extreme discomfort in their feet during pregnancy.

- **Keywords:** Pregnancy; Foot dimensions; 3-D scanner

**François Trudeau, Louis Laurencelle, Claude Lajoie. *Energy expenditure at work in physical education teachers.***

The objective of this study was to quantify work energy expenditure (EE) in physical education (PE) teachers. Sixty-four (64) physical educators (49 men, 15 women) had their individualized linear function between heart rate (HR) and oxygen consumption measured by laboratory testing. HR was then recorded on 2 different days at work to estimate EE, correlated with a diary of daily tasks. Average absolute EE was low-to-moderate ( $2.7 \pm 1.4$  to  $4.6 \pm 2.5$  kcal·min<sup>-1</sup>) and low when expressed in relative values ( $15.3 \pm 6.1\%$  to  $24.8 \pm 7.6\%$  of VO<sub>2</sub>max). However, these physical educators often reached very high intensities (from  $7.5 \pm 7.9\%$  to  $23.8 \pm 22.3\%$  of work time at 100 bpm and more). PE teaching requires a light-to-moderate EE with more intense periods of physical activity. The variety of tasks performed (office work, supervision and monitoring, mixed participation and active participation) significantly influenced EE.

- **Keywords:** Oxygen consumption; Heart rate; Teaching

**Tara Kajaks, Patrick Costigan. *The effect of sustained static kneeling on kinetic and kinematic knee joint gait parameters.***

Despite epidemiological evidence for kneeling as an occupational risk factor for knee osteoarthritis, biomechanical evidence is lacking. Gait knee joint mechanics, a common measure used to study knee osteoarthritis initiation, were used in the present study to investigate the effect of sustained static kneeling on the knee. Ten healthy male subjects ( $24.1$  years  $\pm$   $3.5$ ) performed ten baseline walking trials, followed by a 30-min kneeling protocol and a second set of walking trials. Knee joint moments and angles were calculated during the stance phase. Within-subject root mean squared differences were compared within and between the pre- and post-kneeling gait trials. Differences were observed between the pre-kneeling and post-kneeling walking trails for flexion and adduction knee moments ( $0.12$  Nm/kg  $\pm$   $0.03$ ,  $0.07$  Nm/kg  $\pm$   $0.02$ ) and angles ( $3.18^\circ \pm 1.22$  and  $1.64^\circ \pm 1.15$ ), indicating that sustained static deep-knee flexion kneeling does acutely alter knee joint gait parameters.

- **Keywords:** Gait; Knee osteoarthritis; Kneeling