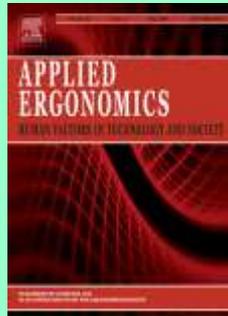


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F. Munoz, A.I. Rouboa, P.R. Rougier. *The balance control effects on sitting posture induced by lumbosacral orthosis wear vary depending on the level of stability.* Pages 511-516.

This study aimed to assess the differential impacts of lumbosacral orthosis (LO) wear in different sitting conditions through posturographic measurements. Twelve healthy subjects sat on a force platform with three variable stability levels (stable and on seesaws with a long and short radius, inferring slightly and highly unstable sitting, respectively) and three orthosis conditions (no LO, neutral LO, lordotic LO). Using fractional Brownian motion modelling of the centre of pressure (CoP) displacements, it appears that a stable sitting position did not highlight any particular differences between the LO models. With the lordotic LO, a slightly unstable sitting position decreased the mean time by 72% ($p < 0.002$) before postural corrective mechanisms took over. In contrast, in highly unstable sitting conditions, the lordotic LO induced larger CoP displacements (increasing variance by 162%, $p < 0.038$). Thus, depending on the amount of perturbation and the device design, wearing an LO may have a neutral, positive or negative impact on postural control in the sitting position.

- **Keywords:** Centre of pressure; Lumbosacral orthosis; Sitting posture

Leon Straker, Rebecca A. Abbott, Marina Heiden, Svend Erik Mathiassen, Allan Toomingas. *Sit-stand desks in call centres: Associations of use and ergonomics awareness with sedentary behavior.* Pages 517-522.

Objective

To investigate whether or not use of sit-stand desks and awareness of the importance of postural variation and breaks are associated with the pattern of sedentary behavior in office workers.

Method

The data came from a cross-sectional observation study of Swedish call centre workers. Inclinometers recorded 'seated' or 'standing/walking' episodes of 131 operators over a full work shift. Differences in sedentary behavior based on desk type and awareness of the importance of posture variation and breaks were assessed by non-parametric analyses.

Results

90 (68.7%) operators worked at a sit-stand desk. Working at a sit-stand desk, as opposed to a sit desk, was associated with less time seated (78.5 vs 83.8%, $p = 0.010$), and less time taken to accumulate 5 min of standing/walking (36.2 vs 46.3 min, $p = 0.022$), but no significant difference to sitting episode length or the number of switches between sitting and standing/walking per hour. Ergonomics

awareness was not associated with any sedentary pattern variable among those using a sit-stand desk.

Conclusion

Use of sit-stand desks was associated with better sedentary behavior in call centre workers, however ergonomics awareness did not enhance the effect.

- **Keywords:** Sedentary behavior; Occupation; Posture; Call centres; Ergonomics awareness

Carolina Ortiz, José J. Castro, Aixa Alarcón, Margarita Soler, Rosario G. Anera. *Quantifying age-related differences in visual-discrimination capacity: Drivers with and without visual impairment.* Pages 523-531.

The aim of this study is to examine the effects of aging as well as visual impairment on retinal-image quality and visual performance in drivers. We use a new visual test called Halo v1.0 software for quantifying the discrimination capacity, an important visual function for evaluating the visual disturbances perceived by the observer. The study included 55 subjects with normal vision and 15 older subjects with cataracts. All subjects were examined for visual acuity, contrast sensitivity, visual-discrimination capacity and optical quality. Subjects also completed a subjective Driving Habits Questionnaire (DHQ). Older drivers with and without visual impairment showed significantly ($p < 0.05$) worse visual performance and deteriorated retinal-image quality, even when their binocular visual acuity was $\geq 20/25$. In conclusion, some visual functions are considerably diminished in older drivers, even when visual acuity is sufficient to get or renew a driver's license. Halo software enables easy quantification of night-vision disturbances such as halos, which could impede the detection of pedestrians, cyclists, or traffic signals, thereby making this system advisable in clinical practice, e.g. in the requirements for a driver's license, particularly for older drivers.

- **Keywords:** Safety driving; Cataract; Visual-discrimination capacity

E. Koppelaar, J.J. Knibbe, H.S. Miedema, A. Burdorf. *The influence of individual and organisational factors on nurses' behaviour to use lifting devices in healthcare.* Pages 532-537.

Aims

This study evaluates the influence of individual and organisational factors on nurses' behaviour to use lifting devices in healthcare.

Methods

Interviews among nurses were conducted to collect individual characteristics and to establish their behaviour regarding lifting devices use. Organisational factors were collected by questionnaires and walk-through-surveys, comprising technical facilities, organisation of care, and management-efforts. Generalised-Estimating-Equations for repeated measurements were used to estimate determinants of nurses' behaviour.

Results

Important determinants of nurses' behaviour to use lifting devices were knowledge of workplace procedures (OR = 5.85), strict guidance on required lifting devices use (OR = 2.91), and sufficient lifting devices (OR = 1.92). Management-support and supportive-management-climate were associated with these determinants.

Conclusion

Since nurses' behaviour to use lifting devices is influenced by factors at different levels, studies in ergonomics should consider how multi-level factors impact each other. An integral approach, addressing individual and organisational levels, is necessary to facilitate appropriate implementation of ergonomic interventions, like lifting devices.

- **Keywords:** Implementation; Lifting device; Behaviour; Nurses; Healthcare

Jin-Seung Choi, Han-Soo Kim, Dong-Won Kang, Mi-Hyun Choi, Hyung-Sik Kim, Sang-Pyo Hong, Na-Rae Yu, Dae-Woon Lim, Byung-Chan Min, Gye-Rae Tack, Soon-Cheol Chung. *The effects of disruption in attention on driving performance patterns: Analysis of jerk-cost function and vehicle control data.* Pages 538-543.

This study analyzes the effects of attention disruption factors, such as sending text messages (STM) and performing searching navigation (SN) on driving performance patterns while actively driving, centering on motion signals. To this end, it analyzes not only data on control of the vehicle including the Anterior-Posterior Coefficient of Variation (APCV), Medial-Lateral Coefficient of Variation (MLCV), and Deviation of Vehicle Speed but also motion data such as the Jerk-Cost function (JC). A total of 55 drivers including 28 males (age: 24.1 ± 1.5 , driving experience: $1.8 \text{ years} \pm 1.7 \text{ years}$) and 27 females (age: 23.8 ± 2.6 , driving experience: 1.5 ± 1.0) participated in this study. All subjects were instructed to drive at a constant speed (90 km/h) for 2 min while keeping a distance of 30 m from the front car also running at a speed of 90 km/h. They were requested to drive for the first 1 min and then drive only (Driving Only) or conduct tasks while driving for the subsequent 1 min (Driving + STM or Driving + SN). The information on APCV, MLCV, and deviation of speed were delivered by a driving simulator. Furthermore, the motion signal was measured using 4 high-speed infrared cameras and based on the measurement results, JCs in a total of 6 parts including left shoulder (L.shoulder), left elbow (L.elbow), left hand (L.hand), right knee (R.knee), right ankle (R.ankle), and right toe (R.toe) were calculated. Differences among the results of 3 conditions of experiment, Driving Only, Driving + STM, and Driving + SN, were compared and analyzed in terms of APCV, MLCV, Deviation of Vehicle Speed, and JC. APCV and Deviation of Vehicle Speed increased in Driving + SN, rather than in Driving Only. MLCV increased in Driving + STM and Driving + SN, rather than in Driving Only. In the case of most JCs except that of L.hand, the values increased in Driving + SN, compared to Driving Only. This study indicated that JC could be a reliable parameter for the evaluation of driving performance patterns. In addition, it was discovered that additional tasks under driving, such as STM and SN, impaired smoothness or proficiency in driving motion, thereby increasing anterior-posterior and medio-lateral variability and deviation of speed.

- **Keywords:** Attention disruption factors; Driving performance; Motion signal; Jerk-cost function

Megan H.W. Preece, Andrew Hill, Mark S. Horswill, Rozemary Karamatic, David G. Hewett, Marcus O. Watson. *Applying heuristic evaluation to observation chart design to improve the detection of patient deterioration.* Pages 544-556.

A key goal for patient safety is to improve the early recognition and management of patients whose conditions deteriorate whilst in hospital. Paper-based observation charts are the main means of recording and monitoring patients' physiological stability, yet observations (e.g., blood pressure, heart rate, and respiratory rate) are not always correctly recorded or appropriately acted upon. No prior published study has applied usability heuristics to systematically compare the usability of multiple observation chart designs. In this study, five evaluators with human factors, applied psychology, or medical expertise inspected 25 observation charts for usability problems. Every chart was found to have substantial usability problems, potentially affecting the ability of hospital staff to accurately record observations or recognize patient deterioration. We proposed a new observation chart design, which avoids many of the previously observed usability problems.

- **Keywords:** Usability inspection; Patient safety; Clinical deterioration

P.M. Arezes, M.M. Neves, S.F. Teixeira, C.P. Leão, J.L. Cunha. *Testing thermal comfort of trekking boots: An objective and subjective evaluation.* Pages 557-565.

The study of the thermal comfort of the feet when using a specific type of shoe is of paramount importance, in particular if the main goal of the study is to attend to the needs of users. The main aim of this study was to propose a test battery for thermal comfort analysis and to apply it to the analysis of trekking boots.

Methodologically, the project involves both objective and subjective evaluations. An objective evaluation of the thermal properties of the fabrics used in the boots was developed and applied. In addition, the thermal comfort provided when using the boots was also assessed both subjective and objectively. The evaluation of the thermal comfort during use, which was simulated in a laboratory environment, included the measurement of the temperature and moisture of the feet. The subjective assessment was performed using a questionnaire.

From the results obtained, it was possible to define an optimal combination of fabrics to apply to trekking boots by considering the provided thermal insulation, air permeability and wicking. The results also revealed that the subjective perception of thermal comfort appears to be more related to the increase in temperature of the feet than to the moisture retention inside the boot. Although the evaluation of knits used in the boots indicated that a particular combination of fibres was optimal for use in the inner layer, the subjective and objective evaluation of thermal comfort revealed that the evaluation provided by users did not necessarily match the technical assessment data. No correlation was observed between the general comfort and specific thermal comfort assessments. Finally, the identification of thermal discomfort by specific foot areas would be useful in the process of designing and developing boots.

- **Keywords:** Thermal; Comfort; Test; Subjective; Objective; Boots

Nicolas Vignais, Markus Miezal, Gabriele Bleser, Katharina Mura, Dominic Gorecky, Frédéric Marin. *Innovative system for real-time ergonomic feedback in industrial manufacturing.* Pages 566-574.

This work presents a system that permits a real-time ergonomic assessment of manual tasks in an industrial environment. First, a biomechanical model of the upper body has been developed by using inertial sensors placed at different locations on the upper body. Based on this model, a computerized RULA ergonomic assessment was implemented to permit a global risk assessment of musculoskeletal disorders in real-time. Furthermore, local scores were calculated per segment, e.g. the neck region, and gave information on the local risks for musculoskeletal disorders. Visual information was fed back to the user by using a see-through head mounted display. Additional visual highlighting and auditory warnings were provided when some predefined thresholds were exceeded. In a user study ($N = 12$ participants) a group with the RULA feedback was compared to a control group. Results demonstrate that the real-time ergonomic feedback significantly decreased the outcome of both globally as well as locally hazardous RULA values that are associated with increased risk for musculoskeletal disorders. Task execution time did not differ between groups. The real-time ergonomic tool introduced in this study has the potential to considerably reduce the risk of musculoskeletal disorders in industrial settings. Implications for ergonomics in manufacturing and user feedback modalities are further discussed.

- **Keywords:** Ergonomics; Real-time; Augmented reality

Hongyi Cai, Paul A. Green, Jong-Jin Kim. *Estimating the legibility of a single letter E viewed at different display angles. Pages 575-587.*

Text is often viewed not perpendicularly to its display. With nine assumptions, this study developed a new equation for estimating the legibility of a single letter E viewed at different display angles. This equation examines viewing distance, text height, strokewidth, Snellen acuity, background luminance, luminance contrast, and incident angle. This equation was derived from the existing Howett's equation based on a constant-solid-angle hypothesis tested in a lighting laboratory by reading letter 'E's using 20 young human subjects. The hypothesis holds when the incident angle $0^\circ \leq \xi \leq 65.7^\circ$, but fails when $65.7^\circ < \xi \leq 82.8^\circ$ (the maximum angle tested). Another ambient-light hypothesis was also tested in the same laboratory using 20 young subjects to verify the negligible influence (less than 9%) of ambient light on legibility of text. The new equation was accordingly improved to help ergonomists and other professionals create and maintain legible displays.

- **Keywords:** Legibility equation; Incident angle; Display

George F. Beard, Michael J. Griffin. *Discomfort during lateral acceleration: Influence of seat cushion and backrest. Pages 588-594.*

Lateral acceleration causes discomfort but how the discomfort depends on the frequency of acceleration or characteristics of seating is poorly understood. Using magnitude estimation, twelve male subjects rated the discomfort caused by lateral oscillation at eight frequencies (0.2–1.0 Hz) across four seating conditions (a rigid seat and a train seat, both with and without backrests). Discomfort increased with increasing frequency of lateral acceleration in a similar manner for all four seating conditions. However, at all frequencies and with both seats there was less discomfort when sitting with backrest support than without. Least discomfort occurred on the train seat with backrest and greatest discomfort on the rigid seat without backrest. Current standards predict an additive effect of backrest on vibration discomfort, but the findings show that low frequency lateral acceleration can cause less discomfort when sitting with a backrest than when sitting on the same seat without a backrest.

- **Keywords:** Vibration; Seating; Discomfort

Victoria Doherty, Darryl Croft, Ashley Knight. *Environmental information for military planning. Pages 595-602.*

A study was conducted to consider the implications of presenting Environmental Information (EI; information on current environmental features including weather, topography and visibility maps) for military planning to the growing audience of non-technical users; to provide guidance for ensuring usability and for development of a suitable EI interface, and to produce an EI concept interface mock-up to demonstrate initial design ideas. Knowledge was elicited from current EI users and providers regarding anticipated use of EI by non-specialists. This was combined with human factors and cognition expertise to produce guidance for data usability and development of an EI interface. A simple mock-up of an EI concept interface was developed. Recommendations for further development were made including application of the guidance derived, identification of a user test-bed and development of business processes.

- **Keywords:** Environmental; Presentation; Usability

Jia-Hua Lin, Raymond W. McGorry, Wayne Maynard. *One-handed standing pull strength in different postures: Normative data. Pages 603-608.*

Although one-handed pulling is commonly used in many tasks, normative data on the populational strength capacity are scarce. A strength test protocol was administered to collect data on static one-handed pulling strength using four handle heights and three pulling directions: across (handle opposite to the pulling hand), front, and side (handle on the same side of the pulling hand). Eighty-six participants (46 men and 40 women) in five age groups completed the protocol. The results showed that pulling from the side of the body resulted in the greatest strength, followed by front and across pulls. As the handle height increased from 61 cm above the floor, to above the shoulder, the pulling strength decreased. This dataset provides occupational safety and ergonomics professionals gender specific normative data on one-handed pull strength capacity in different age groups.

- **Keywords:** Isometric strength; Design; Hand-tool interface; Ageing

Svend Erik Mathiassen, Per Liv, Jens Wahlström. *Cost-efficient measurement strategies for posture observations based on video recordings. Pages 609-617.*

Assessment of working postures by observation is a common practice in ergonomics. The present study investigated whether monetary resources invested in a video-based posture observation study should preferably be spent in collecting many video recordings of the work and have them observed once by one observer, or in having multiple observers rate postures repeatedly from fewer videos. The study addressed this question from a practitioner's perspective by focusing two plausible scenarios: documenting the mean exposure of one individual, and of a specific occupational group. Using a data set of observed working postures among hairdressers, empirical values of posture variability, observer variability, and costs for recording and observing one video were entered into equations expressing the total cost of data collection and the information (defined as $1/SD$) provided by the resulting estimates of two variables: percentage time with the arm elevated $<15^\circ$ and $>90^\circ$. Sixteen measurement strategies involving 1–4 observers repeating their posture ratings 1–4 times were examined for budgets up to €2000. For both posture variables and in both the individual and group scenario, the most cost-efficient strategy at any specific budget was to engage 3–4 observers and/or having observer(s) rate postures multiple times each. Between 17% and 34% less information was produced when using the commonly practiced approach of having one observer rate a number of video recordings one time each. We therefore recommend observational posture assessment to be based on video recordings of work, since this allows for multiple observations; and to allocate monetary resources to repeated observations rather than many video recordings.

- **Keywords:** Cost-efficiency; Exposure assessment; Research budget; Resource consumption

Elisângela Vilar, Francisco Rebelo, Paulo Noriega, Júlia Teles, Christopher Mayhorn. *The influence of environmental features on route selection in an emergency situation. Pages 618-627.*

Understanding the influence of external information at a lower level of awareness during the processes of route selection could be a key factor to predict user's movements within complex buildings, avoiding wayfinding problems and improving egress in emergency situations. This study aims to verify whether corridor intersection configuration attributes, such as width and brightness, act as factors of attraction to improve the

affordance of indoor hallways during an emergency egress situation, using a VR-based methodology. The main hypotheses are that users tend to move along either, wider or brighter corridors. Thirty volunteers participated in this study, moving along 57 different corridors, according to the experimental conditions of the study. The results suggest that people prefer to follow brighter pathways in "T-type" and "F-type" intersections, and wider corridors in "T-type" intersections. In situations where these variables are in conflict, there is a preference for brighter paths in both intersection configurations.

- **Keywords:** Human-environment interaction; Wayfinding; Affordances; Virtual reality; Emergency egress

Kieran O'Sullivan, Peter O'Sullivan, Mary O'Keeffe, Leonard O'Sullivan, Wim Dankaerts. *The effect of dynamic sitting on trunk muscle activation: A systematic review. Pages 628-635.*

The purpose of this systematic review was to investigate the effect of dynamic sitting on trunk muscle activation in sitting. Electronic databases were searched by two independent reviewers. Studies were included if they compared the effect of dynamic sitting on trunk muscle activation to a more static sitting condition. Seven studies were eligible for inclusion, six of which were rated as "high-quality" using the PEDro scale. Five studies reported no difference in trunk muscle activation. Two studies reported a difference in trunk muscle activation, yet this was associated with increased discomfort, increased fatigue and greater spinal shrinkage. Furthermore, the changes reported in these two studies may be more related to the absence of a backrest rather than dynamic sitting. Therefore, the findings of this review suggest dynamic sitting does not significantly change trunk muscle activation. No randomised clinical trials or longitudinal design studies were found which evaluated the effect of dynamic sitting on trunk muscle activation, limiting the ability to make definitive conclusions about causality. The implications of the results, and recommendations for future research, are discussed.

- **Keywords:** Dynamic sitting; Back pain; Muscle

Jaejin Hwang, Hyunjung Shin, Myung-Chul Jung. *Joint motion pattern classification by cluster analysis of kinematic, demographic, and subjective variables. Pages 636-642.*

The purpose of this study is to identify joint motion patterns by classifying the full range of motion (ROM) into several sections. Forty participants were stratified by age and gender and they performed 18 full-swing motions at a self-selected speed. Joint angle, angular velocity, angular acceleration, and subjective discomfort rating were collected for each motion. K-means cluster analyses were used to classify joint motion patterns and ROM sections. The results showed that two or three clusters were mainly determined by the kinematic variables of angular velocity and acceleration. The motions of three clusters showed that the ROM sections of low and moderate velocity with moderate and high accelerations occurred in the initial (negative) and terminal (positive) phases, respectively, whereas those of high velocity with low acceleration were shown in the mid (neutral) phase. The motions of two clusters revealed that while the patterns of high velocity and high acceleration were found on the positive side of the ROM, those of low velocity and low acceleration were on the negative and neutral sides. The ROM sections close to both ends of the ROM may have a larger physical load than the others. This study provides information that could be useful for developing postural analysis tools for dynamic work.

- **Keywords:** Motion pattern; Range of motion; Age; Gender; Discomfort

Khoirul Muslim, Babak Bazrgari, Brad Hendershot, Nima Toosizadeh, Maury A. Nussbaum, Michael L. Madigan. *Disturbance and recovery of trunk mechanical and neuromuscular behaviors following repeated static trunk flexion: Influences of duration and duty cycle on creep-induced effects.* Pages 643-651.

Occupations involving frequent trunk flexion are associated with a higher incidence of low back pain. To investigate the effects of repeated static flexion on trunk behaviors, 12 participants completed six combinations of three static flexion durations (1, 2, and 4 min), and two flexion duty cycles (33% and 50%). Trunk mechanical and neuromuscular behaviors were obtained pre- and post-exposure and during recovery using sudden perturbations. A longer duration of static flexion and a higher duty cycle increased the magnitude of decrements in intrinsic stiffness. Increasing duty cycle caused larger decreases in reflexive muscle responses, and females had substantially larger decreases in reflexive responses following exposure. Patterns of recovery for intrinsic trunk stiffness and reflexive responses were consistent across conditions and genders, and none of these measures returned to pre-exposure values after 20 min of recovery. Reflexive responses may not provide a compensatory mechanism to offset decreases in intrinsic trunk stiffness following repetitive static trunk flexion. A prolonged recovery duration may lead to trunk instability and a higher risk of low back injury.

- **Keywords:** Low back pain; Biomechanics; Creep deformation; Trunk flexion; Stiffness; Reflex; Gender

Barbara Heiden, Matthias Weigl, Peter Angerer, Andreas Müller. *Association of age and physical job demands with musculoskeletal disorders in nurses.* Pages 652-658.

A cross-sectional study design was applied on 273 nurses to investigate associations of physical job demands, age, and musculoskeletal disorders (MSDs) in nursing. Concurrently, participants reported on various physical job demands with a standardized questionnaire for Hospital Work. As a special contribution, this investigation illustrates findings on MSDs provided by a standardized physical examination to questionnaire data. MSD located in the lower back (8.7%) had the highest frequency, followed by the neck (7.3%), the shoulders (6.9%), and the knees (2.2%). There were significant differences in the frequencies of MSD between the young/middle age-group and the old age-group in most locations, while the only significant difference between the young and the middle age-group was found for shoulder-MSD. Furthermore high levels of physical job demands increased the risk of MSD significantly (OR = 5.7, 1.55–20.96) in all age-groups. The study provides further indication for development of age-adapted preventive measures.

- **Keywords:** Musculoskeletal disorders; Physical job demands; Nursing

Yu-Lin Hsiao, Colin Drury, Changxu Wu, Victor Paquet. *Predictive models of safety based on audit findings: Part 2: Measurement of model validity.* Pages 659-666.

Part 1 of this study sequence developed a human factors/ergonomics (HF/E) based classification system (termed HFACS-MA) for safety audit findings and proved its measurement reliability. In Part 2, we used the human error categories of HFACS-MA as predictors of future safety performance. Audit records and monthly safety incident reports from two airlines submitted to their regulatory authority were available for analysis, covering over 6.5 years. Two participants derived consensus results of HF/E errors from the audit reports using HFACS-MA. We adopted Neural Network and Poisson regression methods to establish nonlinear and linear prediction models respectively. These models were tested for the validity of prediction of the safety data, and only

Neural Network method resulted in substantially significant predictive ability for each airline. Alternative predictions from counting of audit findings and from time sequence of safety data produced some significant results, but of much smaller magnitude than HFACS-MA. The use of HF/E analysis of audit findings provided proactive predictors of future safety performance in the aviation maintenance field.

- **Keywords:** Human error; HFACS-MA; Safety prediction; Neural network; Aviation maintenance