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C. Baber, N.A. Stanton, J. Atkinson, R. McMaster & R.J. Houghton. *Using social network analysis and agent-based modelling to explore information flow using common operational pictures for maritime search and rescue operations. Pages 889-905.*

The concept of common operational pictures (COPs) is explored through the application of social network analysis (SNA) and agent-based modelling to a generic search and rescue (SAR) scenario. Comparing the command structure that might arise from standard operating procedures with the sort of structure that might arise from examining information-in-common, using SNA, shows how one structure could be more amenable to 'command' with the other being more amenable to 'control' – which is potentially more suited to complex multi-agency operations. An agent-based model is developed to examine the impact of information sharing with different forms of COPs. It is shown that networks using common relevant operational pictures (which provide subsets of relevant information to groups of agents based on shared function) could result in better sharing of information and a more resilient structure than networks that use a COP.

Practitioner Summary: SNA and agent-based modelling are used to compare different forms of COPs for maritime SAR operations. Different forms of COP change the communications structures in the socio-technical systems in which they operate, which has implications for future design and development of a COP.

- **Keywords:** common operational pictures, common relevant operational pictures, social network analysis, agent-based modelling, command and control, search and rescue

Armağan Kuru & Çiğdem Erbuğ. *Explorations of perceived qualities of on-body interactive products. Pages 906-921.*

Users' perceptions of new forms of products depend on various product qualities. As technology becomes increasingly mobile, carrying technology products on body is becoming more commonplace. As a result, these types of products hold different meanings and intentions for users than off-body products, which may lead to new interpretations. This paper investigates the relationship between the visual qualities of on-body interactive products and users' perceptions of those products. A brief literature review explores how technological developments have led to new modes of transporting

products. This paper also examines the relative importance of changes in perceived qualities, technology acceptance and response to product appearance. Through user interviews, the authors explored the perceived qualities of conceptual designs for wearable phones, the meanings attached to these qualities and their relative importance. They present the results and follow with a discussion of the dimensions of product qualities and related characteristics that emerged.

Practitioner summary: This study, investigating the perceived qualities of on-body interactive products and applying the repertory grid technique, determines what will lead users to avoid or approach these new technologies. It also presents a preliminary framework to help designers understand the perceived qualities of these products.

- **Keywords:** visual product qualities, perceived qualities, experience of visual qualities, on-body interactive products

Sue Lukersmith & Robin Burgess-Limerick. *The perceived importance and the presence of creative potential in the health professional's work environment.* Pages 922-934.

The value of creative employees to an organisation's growth and innovative development, productivity, quality and sustainability is well established. This study examined the perceived relationship between creativity and work environment factors of 361 practicing health professionals, and whether these factors were present (realised) in their work environment. Job design (challenges, team work, task rotation, autonomy) and leadership (coaching supervisor, time for thinking, creative goals, recognition and incentives for creative ideas and results) were perceived as the most important factors for stimulating creativity. There was room for improvement of these in the work environment. Many aspects of the physical work environment were less important. Public health sector employers and organisations should adopt sustainable strategies which target the important work environment factors to support employee creativity and so enhance service quality, productivity, performance and growth. Implications of the results for ergonomists and workplace managers are discussed with a participatory ergonomics approach recommended.

Practitioner summary: Creative employees are important to an organisation's innovation, productivity and sustainability. The survey identified health professionals perceive a need to improve job design and leadership factors at work to enhance and support employee creativity. There are implications for organisations and ergonomists to investigate the creative potential of work environments.

- **Keywords:** creativity, work environment, work organisation, health professional

Mette Korshøj, Peter Krstrup, Tobias Jespersen, Karen Søgaard, Jørgen H. Skotte & Andreas Holtermann. *A 24-h assessment of physical activity and cardio-respiratory fitness among female hospital cleaners: A pilot study.* Pages 935-943.

The aim of this study was to evaluate the feasibility of methods for objective 24-h sampling of physical activity among cleaners. Twenty cleaners participated in three 24-h measurements. Amount of steps, heart rate (HR), cardio-respiratory fitness, body mass index (BMI) and blood pressure were measured. The methods were feasible for the objective 24-h sampling of physical activity and cardio-respiratory fitness among cleaners. Measurements showed that the cleaners walked $20,198 \pm 4,627$ steps per day. During working hours, the average cardio-respiratory load was $25 \pm 6\%$ of heart rate reserve (HRR). The cleaners had a low estimated cardio-respiratory fitness ($34 \text{ mlO}_2/\text{kg}/\text{min}$), a high BMI (50%, $>25 \text{ kg}/\text{m}^2$) and blood pressure (50%, $>120/>80 \text{ mmHg}$). The high amount of steps, the relatively high cardiovascular load at

work and low cardio-respiratory fitness illustrate the need for further investigation of the relationship between physical activity at work and in leisure, and cardiovascular health in this population.

Practitioner Summary: This study evaluated the feasibility of methods for objective 24-h sampling of physical activity among cleaners; the methods used were found to be feasible. The cleaners had a high cardiovascular load at work and low cardio-respiratory fitness, suggesting that there is a need for further investigations.

- **Keywords:** occupational physical activity, occupational health, heart rate reserve, steps per day, cardio-respiratory fitness, feasibility

Joseph F. Seay, Shane G. Sauer, Peter N. Frykman & Tanja C. Roy. *A history of low back pain affects pelvis and trunk mechanics during a sustained lift/lower task.* Pages 944-953.

This study compared three-dimensional trunk and pelvis range of motion (ROM) during a sustained asymmetric box lift/lower task between a group with a history of low back pain (HBP, $n = 9$) and a group with no history of low back pain (NBP, $n = 9$). Participants lifted an 11-kg box for 10 min at 12 cycles/min from ankle height in front to shelves 45 deg off-centre at waist height. Kinematic data were collected at the beginning (min1), middle (min5) and end of the bout (min9). Two-way analyses of variance were performed for all variables. Pelvis and trunk transverse ROM were similar at min1. By min9, HBP group did not change (31.9 ± 9 deg); however, ROM decreased in NBP group (21.6 ± 6 deg, $p < 0.05$). Therefore, despite no current pain, the HBP group demonstrated protective lifting mechanics compared to controls. Also discussed are implications for studying lifting paradigms at sub-maximal effort over longer periods of time.

Practitioner summary: Differences between groups over time demonstrate residual consequences of low back pain (LBP) in a manual materials handling scenario. Individuals with a history of LBP (pain free for 6 months) demonstrated more conservative lifting mechanics towards the end of the bout compared to controls with no history of LBP.

- **Keywords:** box lift lower, biomechanics, kinematics, physiology, manual materials handling, low back pain

Nima Toosizadeh, Babak Bazrgari, Brad Hendershot, Khoirul Muslim, Maury A. Nussbaum & Michael L. Madigan. *Disturbance and recovery of trunk mechanical and neuromuscular behaviours following repetitive lifting: influences of flexion angle and lift rate on creep-induced effects.* Pages 954-963.

Repetitive lifting is associated with an increased risk of occupational low back disorders, yet potential adverse effects of such exposure on trunk mechanical and neuromuscular behaviours were not well described. Here, 12 participants, gender balanced, completed 40 min of repetitive lifting in all combinations of three flexion angles (33, 66, and 100% of each participant's full flexion angle) and two lift rates (2 and 4 lifts/min). Trunk behaviours were obtained pre- and post-exposure and during recovery using sudden perturbations. Intrinsic trunk stiffness and reflexive responses were compromised after lifting exposures, with larger decreases in stiffness and reflexive force caused by larger flexion angles, which also delayed reflexive responses. Consistent effects of lift rate were not found. Except for reflex delay no measures returned to pre-exposure values after 20 min of recovery. Simultaneous changes in both trunk stiffness and neuromuscular behaviours may impose an increased risk of trunk instability and low back injury.

Practitioner summary: An elevated risk of low back disorders is attributed to repetitive lifting. Here, the effects of flexion angle and lift rate on trunk mechanical and neuromuscular behaviours were investigated. Increasing flexion angle had adverse effects on these outcomes, although lift rate had inconsistent effects and recovery time was more than 20 min.

- **Keywords:** low back pain, lifting, trunk flexion, stiffness, reflex, biomechanics

David W. Wagner & Matthew P. Reed. *Step scaling and behaviour selection in a constrained set of manual material handling transfers.* Pages 964-976.

Predictive biomechanical analysis of manual material handling (MMH) transfers is dependent on accurate prediction of foot locations relative to the task. Previous studies have classified common acyclic stepping patterns used during those transfer tasks, but the influence of walking distance prior to the transfer is not well understood. Twenty men and women performed transfers for a minimum of six different delivery distance conditions. The number of steps used by the participants ranged from two to seven. A theoretical framework for idealised step-scaling strategies is proposed and compared with the experimental data. The maximum observed increase in step length prior to delivery was 1.43 times the nominal step length calculated for each participant. The data suggest that although participants can scale their steps to facilitate the use of a single terminal stance at the transfer, the majority of participants chose to utilise a combination of stepping strategies if the preferred contralateral lead foot strategy could not be easily implemented.

Practitioner summary: Accurate foot placements are needed for predictive biomechanical analysis of MMH. A laboratory study investigated the influence of previous step positions on MMH. A *flexible step-scaling strategy*, in which step lengths and strategy were varied, suggests that analysis based on simulated movements should consider multiple lifting postures.

- **Keywords:** manual material handling, lifting, step scaling, turning, steering

Daniel Cury Ribeiro, Gisela Sole, J. Haxby Abbott & Stephan Milosavljevic. *Validity and reliability of the Spineangel® lumbo-pelvic postural monitor.* Pages 977-991.

Objective: to determine the reliability and the concurrent validity of the Spineangel® lumbo-pelvic postural monitoring device. *Methods:* the dynamic lumbo-pelvic posture of 25 participants was simultaneously monitored by the Spineangel® and Fastrak™ devices. Participants performed six different functional tasks in random order. Within-task, within-session and between-day intraclass correlation coefficients (ICC(3,1), ICC(3,5), ICC(2,5), respectively) reliability were calculated for Spineangel® measurements. Concurrent validity of the Spineangel® was assessed by means of a Bland and Altman plot and by means of Pearson's correlation coefficient and paired *t*-test. *Results:* within-task, within-session and between-day ICC for the Spineangel® were found to be excellent (>0.93). The Spineangel® and Fastrak™ pelvic measurements were found to have a good correlation ($R = 0.77$). *Conclusion:* the Spineangel® is a reliable and valid device for monitoring general lumbo-pelvic movements when clipped on the belt or waistband of workers' clothing during various occupational activities.

Practitioner summary: The Spineangel® can be used for assessing lumbo-pelvic posture during work or daily-life activities. This device was found to provide reliable and valid measurements for lumbo-pelvic movements. Further research is required to

determine whether the use of this device is clinically relevant for patients presenting with low back pain.

- **Keywords:** posture, reliability, validity, low back pain

Judith Teresa Bos, Nathalie Charlotte Gerarda Maria Donders, Roel Leonardus Joseph Schouteten & Joost Willem Johannes van der Gulden. *Age as a moderator in the relationship between work-related characteristics, job dissatisfaction and need for recovery. Pages 992-1005.*

Job dissatisfaction and need for recovery are associated with voluntary turnover, absenteeism and diminished health. In the light of encouraging working longer, this study investigated whether the relationships between various work characteristics and job dissatisfaction and need for recovery are dependent on age. Cross-sectional questionnaire data from 591 university employees were divided into four age groups: < 36, 36–44, 45–54 and ≥ 55 years. Multivariate regression analyses were used, including interaction variables to detect a moderating effect of age group. Limited age group effects were found: only the association of Feedback with job dissatisfaction and Task variety with need for recovery were influenced by age group. The salience of specific work characteristics within the age groups varied: for job dissatisfaction, Task variety (< 55) and Changes in tasks (≥ 55) were most important. For need for recovery, this applied to Autonomy (< 36) and Workload (≥ 45). To encourage working longer, age-specific measures could be considered, in addition to individual measures, to respond to individual needs.

Practitioner summary: Demographic changes increase the importance to stimulate working longer. Using questionnaire data, we investigated the relationship between work characteristics, job dissatisfaction and need for recovery in four age groups. Although the moderating effect of age group was rather limited, the salience of specific work characteristics within the age groups varied.

- **Keywords:** ageing, age groups, job demands–resources model, job dissatisfaction, need for recovery, work characteristics

Yuenkeen Cheong, Randa L. Shehab & Chen Ling. *Effects of age and psychomotor ability on kinematics of mouse-mediated aiming movement. Pages 1006-1020.*

The objective of this research is to understand the influence of age and age-related psychomotor ability on the process of mouse-mediated aiming movement. It is premised on the notions that (1) mouse-mediated aiming movements can be better understood via studying its kinematics and (2) age is a surrogate variable in kinematic differences, and that age-influenced fundamental factors such as psychomotor ability may have a more direct effect. As expected, age kinematic differences were detected. However, when comparing with age, age-influenced psychomotor ability (i.e. manual dexterity) contributed more substantially to the variances of kinematics in the ballistic phase. For homing phase, in addition to manual dexterity, age-influenced wrist–finger speed was also a significant contributor. In future studies, it is suggested that components of visual processing should be included for better understanding of its role as an age-influenced fundamental ability in aiming movements. Applications of this research are discussed.

Practitioner Summary: This paper presents empirical data showing age effects in movement kinematics are chiefly mediated by age-related changes in psychomotor ability. Our findings provide additional data for existing and newer performance enhancement solutions, especially for those targeting older adults.

- **Keywords:** aiming movement, movement kinematics, Fitts' pointing task, ageing, psychomotor ability

Jay M. Kapellusch, Arun Garg, Stephen S. Bao, Barbara A. Silverstein, Susan E. Burt, Ann Marie Dale, Bradley A. Evanoff, Frederic E. Gerr, Carisa Harris-Adamson, Kurt T. Hegmann, Linda A. Merlino & David M. Rempel. *Pooling job physical exposure data from multiple independent studies in a consortium study of carpal tunnel syndrome. Pages 1021-1037.*

Pooling data from different epidemiological studies of musculoskeletal disorders (MSDs) is necessary to improve statistical power and to more precisely quantify exposure–response relationships for MSDs. The pooling process is difficult and time-consuming, and small methodological differences could lead to different exposure–response relationships. A sub-committee of a six-study research consortium studying carpal tunnel syndrome: (i) visited each study site, (ii) documented methods used to collect physical exposure data and (iii) determined compatibility of exposure variables across studies. Certain measures of force, frequency of exertion and duty cycle were collected by all studies and were largely compatible. A portion of studies had detailed data to investigate simultaneous combinations of force, frequency and duration of exertions. Limited compatibility was found for hand/wrist posture. Only two studies could calculate compatible Strain Index scores, but Threshold Limit Value for Hand Activity Level could be determined for all studies. Challenges of pooling data, resources required and recommendations for future researchers are discussed.

Practitioner Summary: There is a need for standardised measures and measurement protocols of physical exposure for the upper extremity. This study may provide guidance for those planning to conduct an epidemiological study on quantified job physical exposures, or planning to merge physical exposure data from similar studies with some methodologic differences.

- **Keywords:** methods, ergonomics, NIOSH distal upper extremity consortium, physical exposure data pooling, physical exposure data compatibility, exposure data analysis

Hanatsu Nagano, W.A. Sparrow & Rezaul K. Begg. *Biomechanical characteristics of slipping during unconstrained walking, turning, gait initiation and termination. Pages 1038-1048.*

Slipping biomechanics was investigated on both non-contaminated and oil-contaminated surfaces during unconstrained straight-line walking ('walking'), turning, gait initiation and termination. In walking, backward slipping was more frequent, whereas forward slipping was more frequent when turning. Stopping and gait initiation engendered only forward and backward slipping, respectively. Based on slip distance and sliding velocity, severity of forward slipping was least in walking than for the other gait tasks, whereas the tasks had similar effects on backward slipping. Relative to the dry surface, heel and foot contact angles reduced and heel contact (HC) velocity increased for all gait tasks on the contaminated surface. Ground reaction forces were generally lower on the contaminated surface, suggesting kinetic adaptation immediately following HC. Required coefficient of friction (RCoF) did not correlate with slip distance suggesting that RCoF may not be a useful kinetic parameter for assessing slipping risk on contaminated surfaces.

Practitioner Summary: Slipping is hazardous in everyday locomotion and occupational settings. This study investigated foot control kinematics and kinetics across various gait tasks on both a non-contaminated and an oil-contaminated walking surface. Turning, gait

termination and gait initiation were associated with a greater risk of slip-related falls than unconstrained walking.

- **Keywords:** slip biomechanics, gait initiation and termination, turning, ground reaction force, oil contaminant