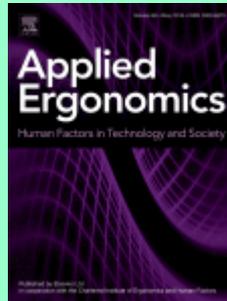


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Georgia Melia, Petros Siegkas, Jodie Levick, Charlotte Apps. *Insoles of uniform softer material reduced plantar pressure compared to dual-material insoles during regular and loaded gait.* 103298.

There is limited evidence on the efficacy of insole materials to reduce plantar pressure during regular walking and loaded walking. In-shoe plantar pressures and subjective footwear comfort were recorded in twenty healthy participants at a self-selected treadmill walking speed in six conditions: two commercial insoles or no insole, and with or without carrying a load in a backpack. A single-material insole, comprised of polyurethane, had reduced density and compressive stiffness compared to a dual-material insole with added viscoelastic material in rearfoot and forefoot regions. Load carriage increased peak pressure across the foot. Both insoles reduced plantar pressure in the rearfoot. Yet, the softer single-material insole also attenuated forefoot pressure and loaded walking did not appear to cause bottoming-out of the polyurethane. Plantar pressure changes did not affect perceived footwear comfort. The softer single-material insole was more effective in reducing plantar pressure, further research would confirm if this influences injury prevalence.

- **Keywords:** Plantar pressure; Density; Load-carriage

Sanaz Agha, Iris C. Levine, Alison C. Novak. *Determining the effect of stair nosing shape on foot trajectory during stair ambulation in healthy and post-stroke individuals.* 103304.

Stair design can influence the risk of stair falls. Stair nosings are intended to provide greater foot accommodation, although to date little is known about how the nosing shape can affect foot trajectory during stair ambulation. This study investigates the impact of different nosing shapes (round, square, tapered, and no nosing) on foot clearance and overhang measures during stair ascent and descent among healthy and post-stroke older adults. Slower cadence in ascent and descent, and greater foot overhang during descent highlighted the increased risk of stair falls for persons with chronic stroke. For both healthy and post-stroke participants, the tapered and round nosing shapes resulted in the largest horizontal foot clearance, and smallest foot overhang, respectively. However, given the greater step-to-step variability detected with round nosings, the tapered nosing presents as the safest choice among all evaluated designs. The results of this work can be used to inform architectural and accessible design standards for a safer built environment.

- **Keywords:** Fall prevention; Aging; Built environment

Adam Hulme, Scott McLean, Clare Dallat, Guy H. Walker, Patrick Waterson, Neville A. Stanton, Paul M. Salmon. *Systems thinking-based risk assessment methods applied to sports performance: A comparison of STPA, EAST-BL, and Net-HARMS in the context of elite women's road cycling.* 103297.

There is increasing interest in applying systems Human Factors and Ergonomics (HFE) methods in sport. Risk assessment (RA) methods can be used identify risks which may impact the performance of individual athletes, teams, and overall sports systems; however, they have not yet been tested in sport. This study sets out to apply and compare three systems thinking-based RA methods in the context of elite sports performance and report on the frequency and types of the risks identified. The Systems-Theoretic Process Analysis (STPA) method, the Event Analysis of Systemic Teamwork Broken Links (EAST-BL) method, and the Networked Hazard Analysis and Risk Management System (Net-HARMS) method were applied to elite women's road cycling to identify all the credible risks that could degrade optimal team performance. The findings demonstrate that all three methods appear to provide useful results in a context other than safety, and that multiple risks threatening the performance of the cycling team were identified. Whilst the frequency and types of risks differed across the methods applied, there are additional theoretical, methodological, and practical implications to be considered prior to the selection and use of systems thinking-based RA approaches. Recommendations and directions for future HFE and sports science research are discussed.

- **Keywords:** Risk assessment; STPA; EAST-BL; Net-HARMS; Sports performance; Cycling

Traci Galinsky, Lena Deter, Edward Krieg, H. Amy Feng, Catherine Battaglia, Revonda Bell, Kathlyn Sue Haddock, Tony Hilton, Charlotte Lynch, Mary Matz, Sarah Moscatel, Franciner D. Riley, Debi Sampsel, Sandra Shaw. *Safe patient handling and mobility (SPHM) for increasingly bariatric patient populations: Factors related to caregivers' self-reported pain and injury.* 103300.

This study was conducted at 5 Veterans Administration Medical Centers (VAMCs). A cross sectional survey was administered to 134 workers who routinely lift and mobilize patients within their workplaces' safe patient handling and mobility (SPHM) programs, which are mandated in all VAMCs. The survey was used to examine a comprehensive list of SPHM and non-SPHM variables, and their associations with self-reported musculoskeletal injury and pain. Previously unstudied variables distinguished between "bariatric" (≥ 300 lb or 136 kg) and "non-bariatric" (< 300 lb or 136 kg) patient handling. Significant findings from stepwise and logistic regression provide targets for workplace improvements, predicting: lower injury odds with more frequently having sufficient time to use equipment, higher back pain odds with more frequent bariatric handling, lower back pain odds with greater ease in following SPHM policies, and lower odds of upper extremity pain with more bariatric equipment, and with higher safety climate ratings.

- **Keywords:** Safe patient handling and mobility (SPHM); Safety program factors; Bariatric patients; Obesity; Overexertion; Musculoskeletal; Injury; Back pain; Upper extremity pain

S. Dungal, M. Smulders, P. Vink. *Implementing spring-foam technology to design a lightweight and comfortable aircraft seat-pan.* 103174.

This paper investigates whether spring-foam technology in an aircraft seat-pan can reduce weight and at the same time provide equal or better comfort. Firstly, through

literature studies and using an iterative design process a prototype seat-pan was designed and developed using spring-foam technology. The (dis)comfort of this seat was compared with a standard aircraft seat-pan. Twenty two participants were asked to sit in each seat for 90 min, completing a questionnaire every 15 min. At the end of each seating session pressure map recordings were made of the seat-pans. The results showed that the prototype seat-pan has on average a significantly higher comfort for the first 30 min and at a 60 min recording than the standard seat-pan. The discomfort and long term comfort were not significantly influenced. The pressure distribution on the prototype seat-pan was significantly closer to an ideal pressure distribution than a conventional seat-pan. In addition, the prototype seat-pan had a significantly larger contact area and lower average pressure. The seat-cushion weighs 20% less than the conventional seat-cushion. The study indicates that a seat-pan design using spring-foam technology can be lighter and more comfortable than conventional foam cushion materials. It is recommended to optimize the prototype seat further and conduct long term (dis)comfort studies with a broader variation in subjects' age.

- **Keywords:** Pressure distribution; Comfort; Aircraft seat; Ideal seat contour

S.M. Hannum, E. Abebe, Y. Xiao, R. Brown, I.M. Peña, A.P. Gurses. *Engineering care transitions: Clinician perceptions of barriers to safe medication management during transitions of patient care.* 103299.

Medication safety during care transitions is a significant challenge, especially for older adults prescribed multiple medications. Using a systems approach to understand barriers to and strategies for safe medication management throughout high-risk periods of hospital-to-home transition is one important step in designing effective interventions. Framing the care transition as a collaboration between healthcare and patient "work systems," we conducted semi-structured interviews with 37 clinical team members, representing 10 different professional roles involved in providing transitional care for patients. Thematic analyses identified key strategies used by clinical team members in preparing patients to self-manage medications safely in the home environment: (1) streamlining and coordinating clinical management of medication reconciliation across care settings; (2) building patient capacity and engagement in self-management of medications; and (3) redesigning the transitional process. Our research highlights the value in aligning professionals' care transition goals with patients and caregiver(s) to better prepare them to self-manage medications upon discharge.

- **Keywords:** Care transitions; Healthcare systems engineering; Medication safety; Qualitative; Patient discharge

Yaar Harari, Avital Bechar, Simone Ascì, Raziel Riemer. *Investigation of 3D dynamic and quasistatic models for spinal moments during combined manual material handling tasks.* 103305.

Digital human modeling software uses biomechanical models to compute workers' risk of injury during industrial work processes. In many cases, the biomechanics are calculated using quasistatic models, which neglect the body's dynamics and therefore might be erroneous. This study investigated the differential effect of using a dynamic vs. a quasistatic model on spinal loading during combined manual material handling tasks that are prevalent in industry. An experiment was conducted involving nine male and nine female participants performing a total of 3402 cycles of a box-conveying task (removing, carrying and depositing) for different box masses and shelf heights. Using motion capture data, the peak and cumulative moments acting on the L5/S1 joint were calculated using 3D dynamic and quasistatic models. This revealed that neglecting the dynamic movements (i.e., using a quasistatic model) results in an on average underestimation of 19.7% in the peak spinal moment and 3.6% in the cumulative moment that in some cases exceeds the maximal limit for the compression forces acting on the lower back.

- **Keywords:** Digital human modeling; L5/S1 moments; Biomechanical model; Ergonomics

Jung Yong Kim, Ji Soo Park, Dong Joon Kim, Sungkyun Im. *Evaluation of fatigue patterns in individual shoulder muscles under various external conditions.* 103280.

For shoulder muscle prevention, we investigated individual shoulder muscle performance and fatigue patterns in various external conditions, including three different % maximum voluntary contractions, six shoulder angles and 60-s durations of exertion. The rating of perceived exertion was also measured for comparison. The upper trapezius (UT), middle deltoid (MD), pectoralis major (PM), latissimus dorsi (LD) and serratus anterior (SA) were selected for assessment. Normalized median power frequency electromyograms were calculated for quantitative fatigue evaluation in ten participants. UT muscle was severely fatigued by extreme flexion angle rather than weight. MD muscle was the most rapidly fatigued after 15 s duration. SA muscle was more fatigued at 0° than 30° adduction. LD and PM muscle fatigue were mostly due to external workload. This muscle specific outcome could help practitioners to design an intervention program targeting particular shoulder injury.

- **Keywords:** Shoulder injury; Muscle-specific intervention; Fatiguing pattern; Normalized median power frequency; Rating of perceived exertion

Tzu-Hsien Lee. *The effects of handle height, load's CoG height and load on lifting tasks.* 103294.

The effect of the load's center of gravity (CoG) on manual materials handling tasks received little attention in literature. The motivation of this study was to examine the effects of handle height, load's CoG height and load on lifting tasks. Eighteen participants performed 27 lifting tasks, including 3 handle heights (10, 30, 50 cm) by 3 load's CoG heights (10, 30, 50 cm) by 3 loads (7, 14, 21 kg). The lifting time, maximum box tilt angle, muscular activity (brachioradialis, biceps brachii, deltoid, and erector spinae), maximum CoP velocity, and lifting difficulty were measured. The results showed that lifting time and maximum box tilt angle decreased with increasing handle height. Middle handle height (30 cm) resulted in the lowest muscular activity, maximum CoP velocity, and lifting difficulty. Low load's CoG height decreased lifting time, maximum box tilt angle, muscular activity, and lifting difficulty, however, it also increased maximum CoP velocity. In addition, high load increased lifting time, maximum box tilt angle, muscular activity, maximum CoP velocity, and lifting difficulty.

- **Keywords:** Manual materials handling; Capacity; Work design

James C. Ferraro, Mustapha Mouloua. *Effects of automation reliability on error detection and attention to auditory stimuli in a multi-tasking environment.* 103303.

Automated aids are engineered to support operators' decision-making in complex and task-saturated environments, alerting them of system status and critical incidents. However, even the most advanced technologies are susceptible to failure. Monitoring imperfect automated systems poses unique challenges related to operator attention and workload. This study empirically examined the effect of unreliable automation on monitoring performance and responses to auditory stimuli in a multi-tasking environment. Participants completed an experimental trial consisting of four flight-related tasks while monitoring for automation failures at one of three levels of automation reliability. Participants in a high reliability condition responded more quickly and frequently to auditory messages. No performance differences were found in system

monitoring performance between reliability conditions. These results are relevant to the design of automated system and delivery of automated alerts, and they have implications for operator attention allocation strategies in multi-tasking environments.

- **Keywords:** Human monitoring of automation; Auditory preemption; Automation reliability; Multi-tasking; Automation-induced complacency

Daniel Sturman, Mark W. Wiggins, William S. Helton, Jaime C. Auton. *The development and validation of a short-duration sustained visual search task for process control environments.* 103302.

This study was designed to validate a short-duration sustained visual search task for the assessment of sustained attention in process control environments. The task consists of 10 short dynamic scenarios, which require participants (N = 121) to monitor simulated operating power transmission interfaces, and identify system faults. A vigilance decrement was demonstrated throughout the sustained visual search task, as evident in increased response latencies and decreased accuracy over time. Further, changes in response latency throughout the sustained visual search task were positively associated with changes in response latency during a 30-min, low signal probability task, a 45-min low signal probability task, and a 45-min high signal probability task. The findings indicate that the sustained visual search task may be a valid alternative to a longer-duration process control task for experimental studies, and is likely to be of value for assessments of the capacity for sustained attention of operators in process control environments.

- **Keywords:** Vigilance; Process control; Power control; Rail control

Michiel Bal, Jos Benders, Steven Dhondt, Lander Vermeerbergen. *Head-worn displays and job content: A systematic literature review.* 103285.

Despite the emergence of head-worn displays at work around forty years ago, few studies have appeared about their impact on job content. To investigate this, a systematic literature review was conducted on these devices and job content, defined as job demands and controls. In total, 3481 studies were identified using five scientific databases. After applying selection criteria, reference searches, citation tracking and an in-depth reading, 28 studies were selected for review. Remarkably, the findings of these studies showed contrasting results. Both increases and decreases in job demands and controls were identified. We distinguished across studies two opposite approaches for the deployment of these devices, i.e. a supportive and a directive approach.

- **Keywords:** Head-worn display; Smart glasses; Job demands and controls; Literature review; Directive and supportive approach

Jang-Ho Park, Kiana Kia, Divya Srinivasan, Jeong Ho Kim. *Postural balance effects from exposure to multi-axial whole-body vibration in mining vehicle operation.* 103307.

Twenty participants (18 males and 2 females) completed postural stability assessments before and after 4-h exposure to whole body vibration (WBV) in four experimental conditions: (a) vertical-dominant WBV with vertical passive air suspension, (b) multi-axial WBV with vertical passive air suspension, (c) multi-axial WBV with multi-axial active suspension, and (d) no WBV condition. Center of pressure (COP)-based postural sway measures significantly increased following multi-axial WBV exposure. Increase in COP velocity and displacement following multi-axial WBV was significantly higher than the increase in all the other exposure conditions. However, no significant differences between the WBV conditions were observed in functional limits of stability and anticipatory

postural adjustments. While our results show standing balance to be impaired following the multi-axial WBV exposure of off-road mining vehicles, dynamic stability across a broader range of conditions needs to be understood to causally link postural stability decrements to increased fall-risks associated with off-road vehicle operators.

- **Keywords:** Whole-body vibration; Mining vehicle; Postural balance

Da Tao, Jihong Zeng, Kaifeng Liu, Xingda Qu. *Effects of control-to-display gain and operation precision requirement on touchscreen operations in vibration environments.* 103293.

Touchscreen has gained increasing popularity. However, little is known about touchscreen use in vibration environments. This study aimed to examine the effects of control-to-display gain (GAIN) and operation precision requirement on touchscreen operations in varied vibration environments. Twenty participants attended an experiment where they were instructed to perform three types of basic touchscreen operation tasks in static, low vibration, and high vibration environments, respectively. Five GAINS (0.75, 1, 2, 3 and 4) and three operation precision requirements (90%, 95%, and 99%) were examined. The results indicated that vibration exerted adverse effects on task performance, and increased perceived workload, perceived task difficulty and discomfort. Task completion time showed a U-shaped curve as GAIN increased. Lowering operation precision requirement improved task performance and reduced perceived workload, especially in vibration environments and at larger GAINS. The findings provide practical implications on the design of usable touchscreen interfaces in vibration environments.

- **Keywords:** Touchscreen operations; Vibration environments; Control-to-display gain; Operation precision requirement

Arne Nieuwenhuys, Jonas Dora, Melanie Knufinke-Meyfroyt, Debby Beckers, Gerard Rietjens, Pieter Helmhout. *"20,000 leagues under the sea": Sleep, cognitive performance, and self-reported recovery status during a 67-day military submarine mission.* 103295.

Employing a field-based monitoring paradigm, the current study examined day-to-day fluctuations in actigraphy-based sleep recordings, cognitive performance (10-min psychomotor vigilance test; PVT), and self-reported recovery status among 14 submariners throughout a 67-day military mission. Mission averages reflected suboptimal sleep that was of short overall duration ($5:46 \pm 1:29$ h per 24-h day) and relatively low efficiency ($82.5 \pm 9.9\%$); suboptimal levels of cognitive performance (PVT mRT = 283 ± 35 ms; PVT response errors = 5.3 ± 4.8); and moderate levels of self-reported recovery. Whilst self-reported recovery status remained stable across mission days, small but consistent day-to-day increases in sleep onset latency and PVT mRT accumulated to reflect meaningful deterioration in sleep and cognitive performance across the entire 67-day mission (i.e., 47% and 16% of the overall mission average, respectively). Future work is required to corroborate the current findings, firmly establish underlying causes, and make evidence-based suggestions for interventions to improve and uphold submariners' health and performance.

- **Keywords:** Sleep; Psychomotor vigilance; Shift-work