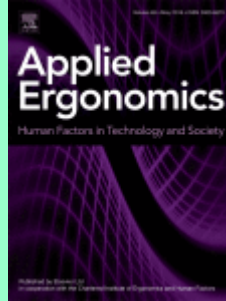


## **Applied Ergonomics - rok 2023, Volume 110**

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**Sudeep Hegde, Ethan Larsen, Olivia Torbett, Siddarth Ponnala, Erin Pohl, Raymond Sze, Monica Miranda Schaeubinger. [A proactive learning approach toward building adaptive capacity during COVID-19: A radiology case study.](#) 104009.**

The COVID-19 pandemic has challenged organizations to adapt under uncertainty and time pressure, with no pre-existing protocols or guidelines available. For organizations to learn to adapt effectively, there is a need to understand the perspectives of the frontline workforce involved in everyday operations. This study implemented a survey-tool to elicit narratives of successful adaptation based on the lived experiences frontline radiology staff at a large multispecialty pediatric hospital. Fifty-eight members of the radiology frontline staff responded to the tool between July and October of 2020. Qualitative analysis of the free-text data revealed five categories of themes that underpinned adaptive capacity of the radiology department during the pandemic: information flow, attitudes and initiative, new and adjusted workflows, availability and utilization of resources, and collaboration and teamwork. Enablers of adaptive capacity included timely and clear communication about procedures and policies from the leadership to frontline staff, and revised workflows with flexible work arrangements, such as remote patient screening. Responses to multiple choice questions in the tool helped identify the main categories of challenges faced by staff, factors that enabled successful adaptation, and resources used. The study demonstrates the use of a survey-tool to proactively identify frontline adaptations. The paper also reports a system-wide intervention resulting directly from a discovery enabled by the findings based on the use of RETIPS in the radiology department. In general, the tool could be used in concert with existing learning mechanisms, such as safety event reporting systems, to inform leadership-level decisions to support adaptive capacity.

- **Keywords:** Proactive learning; Resilient health care; COVID-19; Hospital adaptation

**Aanuoluwapo Ojelade, Wallace Morris, Sunwook Kim, Denean Kelson, Divya Srinivasan, Marty Smets, Maury A. Nussbaum. *Three passive arm-support exoskeletons have inconsistent effects on muscle activity, posture, and perceived exertion during diverse simulated pseudo-static overhead nutrunning tasks.* 104015.**

Arm-support exoskeletons (ASEs) are an emerging technology with the potential to reduce physical demands during diverse tasks, especially overhead work. However,

limited information is available about the effects of different ASE designs during overhead work with diverse task demands. Eighteen participants (gender-balanced) performed lab-based simulations of a pseudo-static overhead task. This task was performed in six different conditions (3 work heights × 2 hand force directions), with each of three ASEs and in a control condition (i.e., no ASE). Using ASEs generally reduced the median activity of several shoulder muscles (by ~12–60%), changed working postures, and decreased perceived exertion in several body regions. Such effects, though, were often task-dependent and differed between the ASEs. Our results support earlier evidence of the beneficial effects of ASEs for overhead work but emphasize that: 1) these effects depend on the task demands and ASE design and 2) none of the ASE designs tested was clearly superior across the tasks simulated.

- **Keywords:** Exoskeleton; Overhead work; Muscle activity; Posture; Shoulder; Perceived exertion

**Anette Karlton, Johan Karlton, Denis Alves Coelho, Karin Havemose, Sofia Kjellström. [The work of first line managers – A key to resilience in manufacturing](#). 103993.**

First-line managers (FLMs) have a vital role in developing stable output and organizational competitiveness through their ability to manage front-line operations in daily work. It is also well known that FLMs are strong determinants of good ergonomics and well-being for front-line staff. However, research focusing on how FLMs deal with their important role is lacking particularly regarding empirical studies. The focus here is how they deal with uncertainties and disruptive interruptions and develop more resilient performance in daily work – introduced in this article as resilient action strategies. This research uses two conceptual frameworks on resilient engineering for analysis of FLM's actions in daily work in two manufacturing companies, to explore how resilient action strategies can be organizationally supported. The study combines analysis of front-line activities with multilevel organizational support based on 30 semi-structured in-depth interviews with FLMs and support functions, 21 workshops as well as policy documents of the two companies. The analysis exemplifies how resilience engineering was enabled in practice in the organizations. The study contributes to the empirical understanding of how resilience can be organizationally supported in daily front-line work. Our results show that a developed and consistent infrastructure in companies promotes the emergence of resilient action strategies in front-line work. We propose an extended model for resilient front-line performance enhancement by including coordination as a linking aspect between the earlier suggested resilient potentials – anticipate, monitor, respond and learn. This highlights the importance of both organizational support and coordination between system levels to enable the development of resilient action strategies by FLMs.

- **Keywords:** Resilience engineering; Coordination; Moments of resilience; Front-line staff ergonomics

**Stephanie Mann, Henrik Baare Olsen, Helene M. Paarup, Karen Søgaaard. [The effects of an ergonomic chinrest among professional violin players. A biomechanical investigation in a randomised crossover design](#). 104018.**

This study aimed to compare violinists' upper body kinematics and muscle activity while playing with different supportive equipment: their usual chinrest (UC) or an ergonomic chinrest (EC), each mounted on the violin. Three-dimensional motion capture and electromyographic data were acquired from the upper body while 38 pain-free professional violinists performed an excerpt of a music piece. There were only minor differences between the two set-ups tested. The EC resulted in less left rotation of the

head (3.3°), slightly more neck extension (1.3°) and less muscle activity (0.5–1.0 %MVE). However, the overall high static muscle activity (4–10 %MVE across all muscles) was maintained using EC. For both setups, the head posture was left-rotated >15°, ≤6° flexed and left-bent 90% of the time. The EC did not produce a substantial difference in biomechanical load. Instead, future studies may focus on aspects other than chinrest design to lower the static workload demands.

- **Keywords:** Violin playing; Body posture; Ergonomics

**Seher Ünver, Esra Makal Orğan. *The effect of anti-fatigue floor mat on pain and fatigue levels of surgical team members: A crossover study.* 104017.**

As ergonomics is important to maintain comfort, this study aimed to examine the effect of anti-fatigue floor mats on pain and fatigue levels of surgical team members. Thirty-eight members participated in this crossover-designed study with no-mat and with-mat conditions, separated by a one-week washout period. They stood on the 15 mm thick rubber anti-fatigue floor mat and on the standard antistatic polyvinyl chloride flooring surface during the surgical procedures. Subjective ratings of pain and fatigue levels were measured pre and after-surgery for each experimental condition using the Visual Analogue Scale and Fatigue-Visual Analogue Scale scales. The after-surgery pain and fatigue levels for the with-mat condition were significantly lower than the no mat condition ( $p < .05$ ). Consequently, anti-fatigue floor mats are effective in decreasing pain and fatigue levels of surgical team members during surgical procedures. Using anti-fatigue mats may be a practical and easy way to prevent discomfort that is often experienced by surgical teams.

- **Keywords:** Anti-fatigue mat; Fatigue; Operating room; Pain; Surgical team member

**George Stilwell, Digby Symons, Shayne Gooch, Jennifer Dunn. *Quantitative functional assessment of multidirectional upper limb strength for individuals in a seated position.* 104023.**

Understanding the limitations that are imposed by a disability is critical to ensure engineers develop designs that can be used by people with reduced function. Current literature lacks detail on this information for people with cervical spinal cord injuries. The purpose of this study was to investigate the reliability of a novel testing methodology to quantitatively assess the multi-directional upper limb strength of individuals in a seated position. Eleven non-disabled males and 10 males with a C4–C7 spinal cord injury completed isometric strength tests on parasagittal (XY) planes using a novel method. Multidirectional (XY) force measurements were taken at discrete points within the participant's reach envelope. Isometric force trends and analysis of the coefficients of variation were used to evaluate the novel methodology. The isometric force trends were consistent in showing a reduction in strength for people with higher injury levels. Analysis of the coefficient of variation showed that the methodology produces repeatable results with an average coefficient of variation of 18% and 19% for the right and left upper limbs, respectively. These results show that the novel testing methodology is a reliable way to gather quantitative multidirectional upper limb strength data for individuals in a seated position.

- **Keywords:** Tetraplegia; Spinal cord injuries; Upper extremity; Static arm strength; Multidirectional isometric force

**Francesco N. Biondi, Frida Graf, Joel Cort. *On the potential of pupil size as a metric of physical fatigue during a repeated handle push/pull task.* 104025.**

Force output and muscle activity represent the gold standards for measuring physical fatigue. This study explores using ocular metrics for tracking changes in physical fatigue during the completion of a repeated handle push/pull task. Participants completed this task over three trials, and pupil size was recorded by means of a head-mounted eye-tracker. Blink frequency was also measured. Force impulse and maximum peak force were used as ground-truth measures of physical fatigue. As expected, a reduction in peak force and impulse was observed over time as participants became more fatigued. More interestingly, pupil size was also found to decrease from trial 1 through trial 3. No changes in blink rate were found with increasing physical fatigue. While exploratory in nature, these findings add to the sparse literature exploring the use of ocular metrics in Ergonomics. They also advance the use of pupil size as a possible future alternative for physical fatigue detection.

- **Keywords:** Measurement; Ocular motor behaviour; Repetitive task; Force; Blink rate; Cognitive load; Ergonomics; Injury; Eye-tracking; Workers; Industry; Muscle; EMG

**Sol Lim, Xiang Yang. *Real-time vibrotactile feedback system for reducing trunk flexion exposure during construction tasks.* 104019.**

Workplaces are increasingly evaluating the use of wearables for ergonomic assessment and providing biofeedback as a real-time postural intervention to improve workers' posture. However, the effectiveness of such intervention systems has yet to be thoroughly investigated in different types of industrial tasks. This study tested the immediate effects of using vibrotactile feedback in simulated construction work tasks including lifting-lowering, shoveling, and tying rebar, to investigate the potential for such an intervention as a way to instruct workers in reducing excessive trunk flexion exposures. Fourteen male participants completed simulated work tasks with three different feedback locations, namely, no feedback, back, and wrist. The results demonstrate that the 95th, 90th, and 50th percentiles of trunk flexion angles are significantly lower for lifting-lowering and shoveling tasks when the feedback system is used. No significant postural changes were observed for the rebar tying task at any combination of percentile and feedback location. The rating of perceived exertion (RPE) for each task did not differ significantly between feedback conditions. Productivity remained the same with the feedback for lifting-lowering and rebar tying, while it was significantly reduced (4.5% of working rate reduction) in shoveling. Participants rated the wrist as the most preferred feedback location. The results of this study suggest that vibrotactile feedback has potential as an effective postural intervention for ergonomic risk factors in selected construction work tasks. Implications for the future design of real-time wearable, sensor-based vibrotactile feedback systems for postural control intervention during dynamic work tasks are discussed.

- **Keywords:** Construction work; Vibrotactile feedback; Real-time postural intervention

**Lea M. Daling, Marisa Tenbrock, Ingrid Isenhardt, Sabine J. Schlittmeier. [\*Assemble it like this! – Is AR- or VR-based training an effective alternative to video-based training in manual assembly?\*](#) 104021.**

AR- and VR-based training is increasingly being used in the industry to train workers safely and effectively for new tasks. In this study, we investigated and compared the effects of AR-, VR- and video-based training on short- and long-term objective

performance measures and subjective evaluations in a manual assembly task. Our results showed that there was no difference between AR-, VR- and video-based training concerning the objective performance measures task completion time and error count. However, in the subjective evaluations VR-based training showed a significantly higher perceived task load and a lower usability rating than the AR- and video-based training regimes. An exploratory analysis additionally revealed partially better results for AR than for VR after adjusting the data for the age of the participants. Future research should further investigate the advantage of AR- and video-based methods over VR when the age and technology experience of participants are taken into account.

- **Keywords:** Virtual reality; Augmented reality; Training and long-term retention

**Stephanie Mann, Helene M. Paarup, Karen Søgaard. [Effects of different violin playing techniques on workload in forearm and shoulder muscles.](#) 103999.**

Due to their working position, violinists are more prone to musculoskeletal pain than other instrumentalists. Playing the violin may cause increased activity in the shoulder and forearm muscles due to techniques such as vibrato (pitch variation), double-fingering (thirds), and changes in speed and volume (piano and forte). This study investigated how the different violin techniques affect muscle activity while playing scales and a music piece. Surface EMG was recorded bilaterally from the upper trapezius and forearm muscles in 18 violinists. Increased playing speed followed by playing with vibrato was the most demanding task affecting the left forearm muscles. Playing forte was the most demanding factor for the right forearm muscles. The music piece and the grand mean of all techniques showed similar workload demands. These results show that specific techniques require higher workload demands and should be considered when planning rehearsals with these techniques as a part of injury prevention.

- **Keywords:** String players; Muscle activity; Playing technique

**Gemma Biviá-Roig, Juan Francisco Lisón, Daniel Sánchez-Zuriaga. *Biomechanical analysis of breastfeeding positions and their effects on lumbopelvic curvatures and lumbar muscle responses.* 104029.**

This study aimed to analyze the position of the lumbopelvic region and lumbar muscle activity in the most common breastfeeding positions. We recorded the curvatures of the lumbar spine and pelvis by means of an electrogoniometer, and the muscle activation levels of the erector spinae with electromyography, in 34 women in erect standing and breastfeeding their children in several positions. Both side lying and clutch-hold positions showed a greater degree of lumbar spine flexion compared to standing. In all sitting postures it was observed that the pelvis was placed in retroversion when compared to standing and side lying. In muscle activity, it was observed that the activation intensity of the right erector in the right side-supported side lying position was significantly lower compared to the rest of breastfeeding postures and standing. Side lying may be a better position to avoid muscle fatigue.

- **Keywords:** Motion analysis; Electromyography; Breastfeeding positions; Lactation

**John A. Aitken, Olivia Pagan, Carol M. Wong, Brooke Bayley, William S. Helton, Seth A. Kaplan. *Task-related and task-unrelated thoughts in runners and equestrians: Measurement issues in evaluations of thought content.* 104011.**

Much of the thought content and mind-wandering literature examines self-reported thought content's relationship with performance criteria in limited ways. Furthermore, retrospective reports about thought content may be influenced by the quality of one's performance. We explored these method issues in a cross-sectional study of individuals competing in a trail race and an equestrian event. Our results demonstrated that self-reports of thought content differed based on the performance context: whereas runners' task-related and task-unrelated thoughts were negatively correlated, equestrians' thought content showed no relationship. Moreover, equestrians in general reported fewer task-related and task-unrelated thoughts than runners. Finally, objective performance predicted task-unrelated thought (but not task-related thought) among runners, and an exploratory mediation test suggested the effect was partially mediated by performance awareness. We discuss the applied implications of this research for human performance practitioners.

- **Keywords:** Task-related thought; Task-unrelated thought; Performance; Mind wandering

**Leonore Schulze-Meeßen, Kai-Christoph Hamborg. *Impact of graphical versus textual sociotechnical prototypes on the generation of mental models in work design.* 104012.**

In an experiment so-termed sociotechnical prototypes based on either a graphical or a textual representation of an envisioned work system were evaluated with regard to their ability to communicate a design vision to people involved in a participatory design process. Results of the study reveal, in line with hypotheses, that the graphical prototype, in contrast to the textual one, was significantly better accepted as well as faster explored and evaluated. Moreover, results support the hypothesis that the graphical sociotechnical prototype helps to build up a more accurate mental representation of the system with regard to its elements (e.g. job roles, tasks). However, no positive effect on the mental representation of the system in terms of the relations between its elements (e.g. which role performs which task?) was found. Finally, practical implications and perspectives for further development of the sociotechnical prototyping approach to envision future work systems are discussed.

- **Keywords:** Sociotechnical design; Work design; Sociotechnical prototype; Participatory design; Mental models

**Kiana Kia, Laurel Kincl, Allen Chan, Jeong Ho Kim. *A fishermen-developed intervention reduced musculoskeletal load associated with commercial Dungeness crab harvesting.* 104016.**

This study characterized physical risk factors associated with injuries during a Dungeness crab harvesting task and evaluated the efficacy of a fishermen-developed ergonomic control (banger bar) in mitigating physical risk factors, including biomechanical loads in the low back, shoulders, and upper extremities, and postural instability. In a repeated-measures laboratory study, 25 healthy male participants performed manual crab harvesting tasks in five conditions: without any banger bar (control) and with 4 bars of differing heights or designs. The results showed that the ergonomic control reduced trunk and shoulder angles, L5/S1, and shoulder moments; muscle activities in low back, shoulders, and upper extremities; perceived exertion ratings; and postural sway measures. Moreover, these measures were lowest when the bar height was at 60 cm,

indicating that the banger bar can reduce the risk of musculoskeletal injuries and postural instability, and that bar height is an important factor affecting these injury risk measures.

- **Keywords:** Commercial fishing; Musculoskeletal disorders; Low back stress; Electromyography; 3-D motion capture

**Monica Tatasciore, Vanessa Bowden, Shayne Loft. [Do concurrent task demands impact the benefit of automation transparency?](#) 104022.**

Automated decision aids typically improve decision-making, but incorrect advice risks automation misuse or disuse. We examined the novel question of whether increased automation transparency improves the accuracy of automation use under conditions with/without concurrent (non-automated assisted) task demands. Participants completed an uninhabited vehicle (UV) management task whereby they assigned the best UV to complete missions. Automation advised the best UV but was not always correct. Concurrent non-automated task demands decreased the accuracy of automation use, and increased decision time and perceived workload. With no concurrent task demands, increased transparency which provided more information on how the automation made decisions, improved the accuracy of automation use. With concurrent task demands, increased transparency led to higher trust ratings, faster decisions, and a bias towards agreeing with automation. These outcomes indicate increased reliance on highly transparent automation under conditions with concurrent task demands and have potential implications for human-automation teaming design.

- **Keywords:** Automation transparency; Concurrent task demands; Uninhabited vehicle control; Decision support systems

**Ao Jiang, Weihao Fang, Jiacheng Liu, Bernard Foing, Xiang Yao, Stephen Westland, Caroline Hemingray. [The effect of colour environments on visual tracking and visual strain during short-term simulation of three gravity states.](#) 103994.**

This study investigated the effects of nine colour environments on visual tracking accuracy and visual strain during normal sitting (SP),  $-12^\circ$  head-down bed (HD) and  $9.6^\circ$  head-up tilt bed (HU). In a standard posture change laboratory study, fifty-four participants performed visual tracking tasks in nine colour environments while in the three postures. Visual strain was measured by means of a questionnaire. The results showed that in all colour environments, the  $-12^\circ$  head-down bed rest posture significantly affected visual tracking accuracy and visual strain. During the three postures, the participants' visual tracking accuracy in the cyan environment was significantly higher than that in other colour environments, and their visual strain was the lowest. Overall, the study adds to our understanding of how environmental and postural factors impact on visual tracking and visual strain.

- **Keywords:** Gravity state; Visual tracking; Visual strain; Virtual space station; Colour environment

**Daniel Cooper, Mark W. Wiggins, Luana C. Main, Jodie A. Wills, Tim Doyle. [Cue utilisation is partially related to performance on an urban operations course but not experience.](#) 104024.**

**Introduction:** Decision making in use of force relies on accurate cue identification to inform appropriate response. This research was designed to test the relationship between cue utilisation and performance prior to, and following participation in an urban operations course (UOC). **Methods:** A total of 37 participants were assessed on cue

utilisation measures, course outcome and between group changes following course participation. **Results:** A significant main effect was evident for Cue utilisation and administration, ( $p = 0.005$ ), but not training group, ( $p = 0.54$ ), nor between groups and point of administration, ( $p = 0.410$ ). No main effect was evident between groups and training outcome, ( $p = 0.11$ ). However, there was a main effect for point of administration, ( $p = 0.02$ ) and training outcome and point of administration ( $p = 0.02$ ). **Conclusion:** Although cue utilisation is an essential component of perception-action tasks, cues may be more specific to the relevant training environment with limited transfer to the operational context.

- **Keywords:** Transfer of training; Use of force; Expertise

**Renée Govaerts, Sander De Bock, Lara Stas, Ilias El Makrini, Jelle Habay, Jeroen Van Cutsem, Bart Roelands, Bram Vanderborght, Romain Meeusen, Kevin De Pauw. [Work performance in industry: The impact of mental fatigue and a passive back exoskeleton on work efficiency. 104026.](#)**

Mental fatigue (MF) is likely to occur in the industrial working population. However, the link between MF and industrial work performance has not been investigated, nor how this interacts with a passive lower back exoskeleton used during industrial work. Therefore, to elucidate its potential effect(s), this study investigated the accuracy of work performance and movement duration through a dual task paradigm and compared results between mentally fatigued volunteers and controls, with and without the exoskeleton. No main effects of MF and the exoskeleton were found. However, when mentally fatigued and wearing the exoskeleton, movement duration significantly increased compared to the baseline condition ( $\beta_{MF:Exo} = 0.17$ ,  $p = .02$ ,  $\omega^2 = .03$ ), suggesting an important interaction between the exoskeleton and one's psychobiological state. Importantly, presented data indicate a negative effect on production efficiency through increased performance time. Further research into the cognitive aspects of industrial work performance and human-exoskeleton interaction is therefore warranted.

- **Keywords:** Robotics; Manufacturing; Mental fatigue

**Steffan Wittrup McPhee Christensen, Thorvaldur Skuli Palsson, Hans Jørgen Krebs, Thomas Graven-Nielsen, Rogerio Pessoto Hirata. [Prolonged slumped sitting causes neck pain and increased axioscapular muscle activity during a computer task in healthy participants – A randomized crossover study. 104020.](#)**

**Introduction:** Sitting posture may contribute to spinal pain. Effects of postures on pain, sensitivity and muscle activity during computer tasks were investigated. **Methods:** Twenty-five healthy participants, seated at a workstation without backrest, completed four, 15-min typing tasks: A)Upright with forearm-support; B)Upright without forearm-support; C)Slumped with forearm-support; D)Slumped without forearm-support. Participants rated pain every minute on a numerical rating scale (NRS). RMS-EMG was recorded from upper/lower trapezius (UT, LT), serratus anterior and anterior/middle deltoid. At baseline and after tasks, pressure pain thresholds (PPTs) were recorded bilaterally over the head, UT, and leg. **Results:** All tasks caused clinically relevant increased NRS ( $\geq 2/10$ ) compared to baseline ( $P < 0.001$ ). NRS was higher in Task-D ( $P < 0.003$ ) and lower in Task-B ( $P < 0.005$ ) than others. PPTs did not change from baseline. Task-D caused higher UT and LT RMS-EMG ( $P < 0.02$ ) than other tasks. **Conclusion:** A 15-min task caused pain irrespective of posture with some causing larger changes than others.



- **Keywords:** Neck pain; Spine; Posture; Pain intensity; Pain sensitivity; Electromyography

**Laura Vieten, Anne M. Wöhrmann, Johannes Wendsche, Alexandra Michel. [Employees' work breaks and their physical and mental health: Results from a representative German survey](#). 103998.**

This study aimed to investigate the prevalence of three characteristics of work break organization, namely skipping work breaks, interruptions of work breaks, and meal break duration, and their relationships with physical and mental health. We used data from the BAuA-Working Time Survey 2017, a representative workforce survey in Germany, and restricted the sample to 5979 full-time employees. Logistic regression analyses were conducted with in total five health complaints as dependent variables: back pain and low back pain, pain in the neck and shoulder region, general tiredness, faintness, or fatigue, physical exhaustion, and emotional exhaustion. Many employees often skipped their work breaks (29%) and experienced break interruptions (16%). Frequent skipping of work breaks was significantly positively, that is detrimentally, related to all five health complaints and frequent interruptions of work breaks also, except for neck and shoulder pain. Meal break duration was significantly negatively, that is beneficially, related to physical exhaustion.

- **Keywords:** Exhaustion; Musculoskeletal pain; Rest break

**C.A.J. Vine, C. Rue, F. Walker, S.D. Blacker, S.D. Myers, J. Doherty. [A comparison of physical performance during one- and two-person simulated casualty drags](#). 104001.**

The ability to drag a casualty to safety is critical for numerous physically demanding occupations. This study aimed to establish whether the pulling forces during a one-person 55 kg simulated casualty drag is representative of a two-person 110 kg drag. Twenty men completed up to 12 × 20m simulated casualty drags using a drag bag (55/110 kg) on a grassed sports pitch, with completion times and forces exerted measured. Completion time for the one-person 55 and 110 kg drags were  $9.56 \pm 1.18$ s and  $27.08 \pm 7.71$ s. Completion time for the 110 kg two-person drags for forwards and backwards iterations were  $8.36 \pm 1.23$ s and  $11.04 \pm 1.11$ s. The average individual force exerted during the one-person 55 kg drag was equivalent to the average individual contribution during the two-person 110 kg drag ( $t(16) = 3.3780$ ,  $p < 0.001$ ); suggesting a one-person 55 kg simulated casualty drag is representative of the individual contribution to a two-person 110 kg simulated casualty drag. Individual contributions can however vary during two-person simulated casualty drags.

- **Keywords:** Military; Occupation; Physically demanding; Physical employment standards; Extraction

**Erin L. Stevens, Adam Hulme, Natassia Goode, Lauren Coventon, Gemma Read, Paul M. Salmon. *Understanding complexity in a safety critical setting: A systems approach to medication administration*. 104000.**

'Medication errors' are a significant concern and are associated with a higher incidence of adverse events and unintentional patient harm than any other aspect of healthcare. While much research has focused on adverse medication errors, limited studies have specifically examined 'normal' medication delivery performance and the interactions between tasks, agents, and information within the medication administration system. This article describes a study that applied the Event Analysis of Systemic Teamwork (EAST) model to study the hospital medication administration system to identify opportunities to optimise performance and patient safety. Key findings of this study

demonstrate that this is a highly complex system, comprising many social agents and a relatively closely linked series of tasks and information. However, most of the workload relies on a small proportion of healthcare professionals. Significantly, the patient has a minimal role in the medication administration system during their hospital stay. The research has shown that this approach enables mapping networks and their interdependencies to optimise the system as a whole rather than its parts in isolation.

- **Keywords:** Medication administration system; Patient safety; Event analysis of systemic teamwork

**Steven A. Lavender, John Charbonnet, Carolyn M. Sommerich.**  
***Biomechanical assessment of alternative hand trucks for transporting heavy loads up and down stairs. 104010.***

Hand trucks are frequently used in delivery and moving occupations to move a variety of materials including appliances and beverages. Frequently these transport tasks involve ascending or descending stairs. This research assessed the efficacy of three commercially available alternative hand truck designs that could be used to deliver appliances. Nine experienced participants moved a 52.3 kg washing machine up and down a flight of stairs using a conventional two-wheeled hand truck, a multi-wheeled hand truck, and a two-speed powered hand truck. Electromyographic (EMG) data showed reduced right erector spinae, bilateral trapezius, and bilateral biceps 90th and 50th percentile normalized responses while ascending and descending the stairs when using the powered hand truck. The multi-wheel hand truck did not reduce EMG levels relative to the conventional hand truck. Participants, however, did express a potential concern regarding the ascent time with powered hand truck at the slower speed.

- **Keywords:** Hand truck; Stairs; Delivery; Intervention assessment; Musculoskeletal disorders (MSD)