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Aaron J. Derouin, Andrew J. Law, Heather Wright Beatty, Viresh Wickramasinghe & Steven L. Fischer. *The effects of whole-body vibration and head supported mass on performance and muscular demand*. Pages: 1-15.

For military rotary-wing aircrew, little is known about the interactive effects of vibration exposure and the addition of head supported mass (HSM) on target acquisition performance, head kinematics, and muscular demand. Sixteen healthy male participants wore an aviator helmet with replica night vision goggles and completed rapid aiming head movements to acquire visual targets in axial and off-axis movement trajectories while secured in a Bell-412 helicopter seat mounted to a human-rated shaker platform. HSM configuration (with or without a counterweight (CW)) and vertical whole-body vibration (WBV) conditions (vibration or no vibration exposure) were manipulated as independent variables. WBV exposure degraded target acquisition performance and lengthened time to peak velocity of head movements. For yaw peak velocity in the axial movement trajectory, peak velocity was 9.9%, 11.6%, and 8.4% higher in the noCW + WBV condition compared to the CW + WBV, CW + noWBV, and noCW + noWBV conditions, respectively. **Practitioner summary:** The majority of military helicopter aircrew use a counterweight to counteract the anteriorly displaced load of night vision goggles. This study was undertaken to better understand how helicopter vibration and counterweight use interactively affect performance and health-related measures during rapid scanning head movements.

- **Keywords:** Vibration, neck pain, rotary-wing, biomechanics injury

Lisanne Bergefurt, Rianne Appel-Meulenbroek, Celine Maris, Theo Arentze, Minou Weijs-Perrée & Yvonne de Kort. [*The influence of distractions of the home-work environment on mental health during the COVID-19 pandemic*](#). Pages: 16-33.

Previous research showed that office workers are mainly distracted by noise, influencing their mental health. Little investigation has been done into the influence of other workspace characteristics (i.e. temperature, amount of space, visual privacy,

adjustability of furniture, wall colours, and workspace cleanliness) on distractions at the office, and even fewer while working from home (WFH). The influence of home-workspace distractions on mental health also received limited attention. This research aims to investigate relationships between home-workspace and personal characteristics, distraction, and mental health while WFH during COVID-19. A path analysis approach was used, to find that, at home, employees were distracted by noise and when having a small desk. Those with a dedicated workroom were less distracted. Distractions mediated most relationships between home-workspace characteristics and mental health, while personal characteristics influenced mental health directly. Employers can use these results to redesign policies regarding home-and-office working to stimulate a healthy work environment. **Practitioner summary:** The investigation of the influence of home-workspace characteristics on distractions and mental health while WFH during COVID-19 appears to be limited. This research filled this gap by performing a path analysis, using a holistic definition of mental health. Findings showed that distractions mediate relationships between home-workspace characteristics and mental health.

- **Keywords:** Working from home, mental health, workspace distractions, COVID-19 pandemic, noise

Suyoung Kwon, Soo-Jeong Lee, Stephen Bao, A. B. de Castro, Jerald R. Herting & Kurt Johnson. *Interaction between physical demands and job strain on musculoskeletal symptoms and work performance.* Pages: 34-48.

This study investigated the interaction between physical demands and job strain on musculoskeletal symptoms in upper extremities (MSUE) and work performance. Two years of prospective data were analysed from 713 full-time workers from twelve manufacturing and healthcare facilities in Washington in the United States. Physical exposure was measured by the Strain Index and Threshold Limit Value for hand activity, giving rise to safe, action, and hazardous physical demand groups. Job strain was calculated as the ratio of psychological job demands to job control. Multilevel modelling analysis showed that job strain affected MSUE and limited work performance less in the high physical demand group than the safe group because the protective effect of job control was smaller in these groups. Findings may suggest that high physical demand jobs are structured such that workers have low job control or high physical demand groups experience job strain not adequately captured by psychosocial variables. **Practitioner Summary:** The effects of job strain and job control on musculoskeletal symptoms in upper extremities and work performance were smaller among workers with higher physical demands. This could imply that high physical demand jobs limit job control or psychosocial variables may not adequately capture job strain among high physical demand groups.

- **Keywords:** Interaction, musculoskeletal disorder, work disability, occupational stress, job control, ergonomics

Edward Ashworth, James Cotter & Andrew Kilding. *Post-exercise, passive heat acclimation with sauna or hot-water immersion provide comparable adaptations to performance in the heat in a military context.* Pages: 49-60.

To mitigate the effects of heat during operations in hot environments, military personnel will likely benefit from heat acclimation (HA) conducted prior to deployment. Using post-exercise, passive heating, 25 participants completed a 5 d HA regime in sauna (70 °C, 18% RH) or hot-water immersion (HWI) (40 °C) for ≤40 min, preceded and followed by a heat stress test (1-h walking at 5 km.h⁻¹ in 33 °C, 77% RH in military uniform (20 kg) before an incremental ramp to exhaustion). Fifteen completed both regimes in a

randomised, cross-over manner. While performance did not significantly improve (+14%, [-1, 29], $p = .079$), beneficial adaptations were observed for mean exercising core temperature (-0.2 °C, [-0.2, -0.2], $p < .001$), skin temperature (-0.2 °C, [-0.2, -0.2], $p = 035$) and heart rate (-8 bpm, [-6, -10], $p < .001$) in both conditions. Post-exercise, passive HA of either modality may benefit military units operating in the heat. **Practitioner summary:** Strategies are required to prevent health and performance impairments during military operations upon arrival in hot environments. Using a randomised, cross-over design, participants completed five-day passive, post-exercise heat acclimation using sauna or hot-water immersion. Both regimes elicited beneficial albeit modest heat adaptations.

- **Keywords:** Thermoregulation, military, acclimation, heat, physiology

Dominic J. Farris, David J. Harris, Hannah M. Rice, James Campbell, Alistair Weare, Debbie Risius, Nicola Armstrong & Mark P. Rayson. [*A systematic literature review of evidence for the use of assistive exoskeletons in defence and security use cases.*](#) **Pages: 61-87.**

Advances in assistive exoskeleton technology, and a boom in related scientific literature, prompted a need to review the potential use of exoskeletons in defence and security. A systematic review examined the evidence for successful augmentation of human performance in activities deemed most relevant to military tasks. Categories of activities were determined a priori through literature scoping and Human Factors workshops with military stakeholders. Workshops identified promising opportunities and risks for integration of exoskeletons into military use cases. The review revealed promising evidence for exoskeletons' capacity to assist with load carriage, manual lifting, and working with tools. However, the review also revealed significant gaps in exoskeleton capabilities and likely performance levels required in the use case scenarios. Consequently, it was recommended that a future roadmap for introducing exoskeletons to military environments requires development of performance criteria for exoskeletons that can be used to implement a human-centred approach to research and development.

Practitioner Summary: We assessed the state-of-the-art for the use of wearable assistive exoskeletons in UK defence and security use cases. A full systematic review of the literature was undertaken, informed by use cases developed in military stakeholder workshops. Clear gaps in exoskeleton capability and use case requirements were identified, leading to recommendations for future work.

- **Keywords:** Exoskeletons, military, human factors, use case, load carriage, manual handling

Juergen Sauer, Carlotta Centner, Sara Longhi, Claire Siggen & Luana Tettamanti. [*Social stress, performance after-effects and extra-role behaviour.*](#) **Pages: 88-100.**

The article is concerned with the after-effects of social stress on work performance. In a lab-based experiment, seventy participants were assigned to either a stress condition or a no-stress condition. In the stress condition, participants received fake negative performance feedback and they were ostracised by two confederates of the experimenter. Participants carried out the following tasks: attention and divergent creativity. The effects of social stress were examined at three levels: performance after-effects on unscheduled probe tasks, extra-role behaviour and subjective operator state. The manipulation check confirmed that participants experienced social stress. The results showed after-effects of social stress for some forms of extra-role behaviour (i.e. spontaneous reactions) and for the accuracy component of attention. Furthermore, social stress was found to increase negative affect and to reduce self-esteem. The findings point to the importance of assessing different types of after-effects rather than limiting

the methodological approach to instant effects on performance. **Practitioner summary:** The study aimed to examine the multiple effects of social stress. Social stress resulted in increased negative affect and lower self-esteem. Furthermore, social stress was found to reduce the propensity of humans to show extra-role behaviour (i.e. providing spontaneous help to others).

- **Keywords:** Social stress, after-effects, extra-role behaviour, performance, negative feedback, ostracism

Magdalena Zawadka, Jakub Smolka, Maria Skublewska-Paszkowska, Edyta Lukasik, Mirosław Jablonski & Piotr Gawda. *The influence of sedentary behaviour on lumbar-pelvic kinematics during squatting and forward bending among physically active students.* Pages: 101-112.

Prolonged sitting may involve several mechanisms that make it a risk factor for low back pain. The aim of this study was to investigate lumbar-pelvic kinematics and multifidus muscle (MF) activity during squatting and forward bending in relation to the sedentary behaviour of physically active students. Sixty-three students were divided into two groups according to the time spent in a sitting position during the day: 'high' (>7 h/day); 'low' (≤7 h/day). Lumbar-pelvic ratios, ranges of motion, angular velocities, and MF flexion-relaxation phenomenon were investigated. Data were obtained using the optical motion analysis system, and surface electromyography. The results indicated that lumbar-pelvic ratios during both tasks and velocity of lumbar spine during squatting were significantly greater in the 'high' than in the 'low' sitting group. Muscle activity showed no differences between groups. Prolonged sitting can be considered a factor that slightly, but statistically significantly influences the lumbar-pelvic kinematics in physically active people. **Practitioner summary:** Lumbar-pelvic kinematics can be altered by prolonged sitting in physically active students. Lumbar-pelvic ratios during squatting and forward bending and lumbar spine velocity during squatting were significantly greater in the 'high' than in the 'low' sitting group. Sedentary behaviour should be considered during an assessment of movement patterns.

- **Keywords:** Physical activity, electromyography, sitting position, spine

Sheldon J. Hawley, Andrew Hamilton-Wright & Steven L. Fischer. *Detecting subject-specific fatigue-related changes in lifting kinematics using a machine learning approach.* Pages: 113-124.

Individual responses to fatigue have been observed in lifting kinematics, suggesting a subject-specific approach is necessary for fatigue identification. One-class support vector machines (OCSVM) may provide an objective method to classify fatigue-related kinematic changes during repetitive lifting. Participants completed a repetitive lifting protocol while motion capture recorded lifting motions. Subject-specific kinematics from participants' first 35% of lifts trained OCSVM decision boundaries. The remaining lifts were separated into test sets and classified against the decision boundary to identify the percentage of outlier lifts within each test set. Spearman's correlation assessed if the test sets' percentage of outlier lifts increased concurrently with participants' rating of perceived exertion (RPE). Significant positive associations were found for participants who demonstrated evidence of fatigue, while no significant associations were found for participants who did not demonstrate evidence of fatigue. These results demonstrate the prospective efficacy of an outlier detection tool for fatigue detection during repetitive lifting. **Practitioner Summary:** An objective subject-specific fatigue detection method is desired for workplace tasks, such as lifting. An outlier detection machine learning approach was identified when lifting movement patterns changed from baseline throughout a repetitive lifting protocol. Participants who demonstrated an increase in outlier movement patterns had a concurrent increase in self-reported fatigue.

- **Keywords:** Machine learning, pattern recognition, manual materials handling, biomechanics, support vector machine

Kenneth M. Jackson, Tyler H. Shaw & William S. Helton. *The effects of dual-task interference on visual search and verbal memory.* Pages: 125-135.

The operational costs of multitasking are more pressing given the increase in wearable technologies (head-up displays; HUDs) that facilitate multitasking. Often multitasking comes with performance costs, where the addition of more tasks impairs the performance of the tasks. The current study explored the extent to which multitasking interference can be characterised in simulated environments, as opposed to risky and harsh environments in real operational contexts. Forty-eight participants completed several trials where they performed a visual search task while navigating a simulated environment. There were three conditions: a standalone memory task, a standalone search task, and both tasks simultaneously. Results revealed significant dual-task interference when comparing the dual-task to each of the single-tasks. Results were corroborated by subjective workload and stress metrics. The results could prove useful for designing systems for individuals who routinely multitask in operational environments. Specifically, by furthering the understanding of their performance capabilities and trade-offs due to multitasking. **Practitioner summary:** Due to the demands of multitasking in operational environments, quantifying the degree of information lost on each task individually will aid in the understanding of the deficits of multitasking performance. This study shows that deficits in multi-tasking (via a HUD) can be understood in simulated environments to a similar degree as real-world tasks.

- **Keywords:** Multitasking, virtual reality, augmented reality, verbal recall, visual search

Maël Amari & Nellie Perrin. *Whole-body vibration exposure in unfavourable seated postures: apparent mass and seat-to-head transmissibility measurements in the fore-and-aft, lateral, and vertical directions.* Pages: 136-151.

Mobile machinery operators are exposed to whole-body vibrations (WBV) and unfavourable postures which may lead to adverse effects on the spine. 14 subjects were exposed to WBV on a rigid seat without a backrest. They adopted nine different postures. Apparent mass $MA(f)$ and seat-to-head transmissibility $T(f)$ were measured in the horizontal (X), lateral (Y) and vertical (Z) directions. They were compared to the reference posture from the ISO 2631-1 standard. Head and thorax inclinations in the sagittal plane had significant effects. An increase in the main resonant frequency f_r , together with a decrease in $|MA(f)|_{max}$ were observed in the Z direction. A second lower frequency peak also appeared ($f_r \approx 1$ Hz for X, $f_r \approx 2.5$ Hz for Z). f_r increased in the X and Z directions for $|T(f)|$. $|T(f)|_{max}$ increased in the X direction. Head and thorax inclinations in the frontal and the horizontal planes had weak or non-significant effects. **Practitioner summary:** Mobile machinery operators are exposed to whole-body vibration and unfavourable body posture. Laboratory measurements of the apparent mass $MA(f)$ and the seat-to-head transmissibility $T(f)$ in the horizontal (X), lateral (Y) and vertical (Z) directions are presented for 9 postures relevant to the exposure at the driving position and to the effects of vibration on the spine.

- **Keywords:** Drivers, whole-body vibration, posture, apparent mass, seat-to-head transmissibility