

# **Human Factors – rok 2021, roč. 63**

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### **Special Issue: Systematic Reviews**



**Peter J. Keir, Amanda Farias Zuniga, Daanish M. Mulla, Kumara G. Somasundram. Relationships and Mechanisms Between Occupational Risk Factors and Distal Upper Extremity Disorders. pp. 5–31.**

**Objective:** The relationships between workplace risk factors and upper extremity injuries from epidemiological and laboratory studies were examined. **Background:** Epidemiological studies are associated with several limitations, affecting the strength of association between risk factors and the development of injuries. **Method:** In this narrative review, we identified epidemiological and laboratory studies (published primarily since 1997) investigating exposure to workplace risk factors (force, repetition, posture, vibration) and risk of hand/wrist tendon-related disorders, epicondylitis, and carpal tunnel syndrome (CTS). **Results:** Forceful exertions are strongly associated with hand/wrist tendon-related disorders, epicondylitis, and CTS. Dose-response relationships were found for epicondylitis (repetition) and CTS (posture). Interactions demonstrate multiplicative effects of risk factors for injury risk. Laboratory studies display clear associations between task demands and biomechanical measures linked to mechanisms for upper extremity injuries with animal models providing further evidence of a dose-response between risk factors and injury. **Conclusion:** Forceful, repetitive work requiring non-neutral postures are associated with increasing risk of hand/wrist tendon-related disorders, epicondylitis, and CTS as evidenced by epidemiology studies and laboratory-based investigations of humans and animals. **Application:** Understanding the relationship between exposure levels of workplace risk factors and upper extremity disorders can improve injury prevention and rehabilitation strategies.

- **Keywords:** epidemiology, biomechanics, upper extremity, musculoskeletal system, injury

**Sadaf Kazi, Salar Khaleghzadegan, Julie V. Dinh, Mark J. Shelhamer, Adam Sapirstein, Lee A. Goeddel, Nnenna O. Chime, Eduardo Salas,**

**Michael A. Rosen. Team Physiological Dynamics: A Critical Review. pp. 32–65.**

**Objective:** Review the use of physiological measurement in team settings and propose recommendations to improve the state of the science. **Background:** New sensor and analytical capabilities enable exploration of relationships between team members' physiological dynamics. We conducted a review of physiological measures used in research on teams to understand (1) how these measures are theoretically and operationally related to team constructs and (2) what types of validity evidence exist for physiological measurement in team settings. **Method:** We identified 32 articles that investigated task-performing teams using physiological data. Articles were coded on several dimensions, including team characteristics. Study findings were categorized by relationships tested between team physiological dynamics (TPD) and team inputs, mediators/processes, outputs, or psychometric properties. **Results:** TPD researchers overwhelmingly measure single physiological systems. Although there is research linking TPD to inputs and outputs, the research on processes is underdeveloped. **Conclusion:** We recommend several theoretical, methodological, and statistical themes to expand the growth of the TPD field. **Application:** Physiological measures, once established as reliable indicators of team functioning, might be used to diagnose suboptimal team states and cue interventions to ameliorate these states.

- **Keywords:** team physiology, group processes, team dynamics, team performance measurement, physiological measurement

**Luke Crameri, Imali Hettiarachchi, Samer Hanoun. A Review of Individual Operational Cognitive Readiness: Theory Development and Future Directions. pp. 66–87.**

**Objective:** The aim of this paper is to provide a comprehensive and original review of the theoretical development of the individual operational cognitive readiness (OCR) theory. **Background:** Cognitive readiness (CR) is a concept that has the potential to predict the performance of human individuals and teams prior to engaging in complex, dynamic, and resource-limited task environments. However, the current state of the literature is confusing and laborious, with heterogeneous views regarding the theoretical frameworks among leading researchers. **Method:** This review (1) undertakes a systematic approach toward categorizing published CR literature into theoretical and measurement contributions across the different levels of CR, (2) carries a critical evaluation of the CR and OCR theoretical frameworks, and (3) provides directions for future research guided by gaps identified during the review process and other published literatures. **Results:** Results from the categorization of published CR literature provide a new, valuable, synthesized CR library for researchers to consult to streamline their CR literature review process. Critical examination of the CR and OCR theoretical frameworks leads to positing that new components should be explored for OCR. **Conclusion:** There are many possible directions for future research including evaluating domain-independent components of OCR and evaluating the relationship between biofeedback measures and performance in CR models. **Application:** The Defense domain continues to be the focal application of CR. However, CR could be used by other application domains, such as sports and emergency services, that require their working personnel to engage in complex, uncertain, and dynamic task environments.

- **Keywords:** cognitive modeling, decision-making, metacognition, motivation, situational awareness, stress

**Tiffany M. Bisbey, Molly P. Kilcullen, Eric J. Thomas, Madelene J. Ottosen, KuoJen Tsao, Eduardo Salas. Safety Culture: An Integration of Existing**

**Models and a Framework for Understanding Its Development.** pp. 88–110.

**Objective:** This study reviews theoretical models of organizational safety culture to uncover key factors in safety culture development. **Background:** Research supports the important role of safety culture in organizations, but theoretical progress has been stunted by a disjointed literature base. It is currently unclear how different elements of an organizational system function to influence safety culture, limiting the practical utility of important research findings. **Method:** We reviewed existing models of safety culture and categorized model dimensions by the proposed function they serve in safety culture development. We advance a framework grounded in theory on organizational culture, social identity, and social learning to facilitate convergence toward a unified approach to studying and supporting safety culture. **Results:** Safety culture is a relatively stable social construct, gradually shaped over time by multilevel influences. We identify seven enabling factors that create conditions allowing employees to adopt safety culture values, assumptions, and norms; and four behaviors used to enact them. The consequences of these enacting behaviors provide feedback that may reinforce or revise held values, assumptions, and norms. **Conclusion:** This framework synthesizes information across fragmented conceptualizations to clearly depict the dynamic nature of safety culture and specific drivers of its development. We suggest that safety culture development may depend on employee learning from behavioral outcomes, conducive enabling factors, and consistency over time. **Application:** This framework guides efforts to understand and develop safety culture in practice and lends researchers a foundation for advancing theory on the complex, dynamic processes involved in safety culture development.

- **Keywords:** safety culture and behavior change, social processes, teams and groups, organizational psychology, social psychology

**Sarah Tinali, Kelly-Ann Bowles, Jennifer L. Keating, Terry Haines. Sitting Posture During Occupational Driving Causes Low Back Pain; Evidence-Based Position or Dogma? A Systematic Review.** pp. 111–123.

**Objective:** In this review, we determine if there is evidence to demonstrate a relationship between occupational driving posture and low back pain. **Background:** The burden of low back pain is increasing. An understanding of this relationship is required to enable the development of recommendations for clinicians and policy-makers for the driving industry. **Method:** Five databases were searched up to March 12, 2018. Study quality was assessed using the National Heart, Lung, and Blood Institute's Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies, followed by a GRADE analysis to consider the evidence as a whole. A narrative, critical synthesis was completed that considered the methods by which driving posture and low back pain were measured and analyzed. **Results:** There were 653 articles identified, with seven eligible for review. Four articles identified an association between occupational driving posture and low back pain, yet this was based on the use of measurement tools lacking validity. Although a relationship may exist, the specific driving postures associated with low back pain and the strength of this relationship have not been confirmed. **Conclusion:** Future research needs to employ validated and reliable, real-time qualitative methods for measuring occupational driving posture to advance our understanding of this relationship. **Application:** Clinical and policy recommendations regarding driving posture and low back pain should be used with caution, as they are guided by evidence incorporating bias. Future studies are required to confirm the specific postures assumed while occupational driving and their relationship with low back pain, before recommendations can be made.

- **Keywords:** occupation, occupational health, workplace injury, musculoskeletal, spine

**Mica R. Endsley. A Systematic Review and Meta-Analysis of Direct Objective Measures of Situation Awareness: A Comparison of SAGAT and SPAM. pp. 124–150**

**Objective:** To examine evidence of sensitivity, predictiveness, and methodological concerns regarding direct, objective measures of situation awareness (SA). **Background:** The ability to objectively measure SA is important to the evaluation of user interfaces and displays, training programs, and automation initiatives, as well as for studies that seek to better understand SA in both individuals and teams. A number of methodological criticisms have been raised creating significant confusion in the research field. **Method:** A meta-analysis of 243 studies was conducted to examine evidence of sensitivity and predictiveness, and to address methodological questions regarding Situation Awareness Global Assessment Technique (SAGAT), Situation Present Assessment Technique (SPAM), and their variants. **Results:** SAGAT and SPAM were found to be equally predictive of performance. SPAM (64%) and real-time probes (73%) were found to have significantly lower sensitivity in comparison to SAGAT (94%). While SAGAT was found not to be overly memory reliant nor intrusive into operator performance, SPAM resulted in problems with intrusiveness in 40% of the studies examined, as well as problems with speed-accuracy tradeoffs, sampling bias, and confounds with workload. Concerns about memory reliance, the utility of these measures for assessing Team SA, and other issues are also addressed. **Conclusion:** SAGAT was found to be a highly sensitive, reliable, and predictive measure of SA that is useful across a wide variety of domains and experimental settings. **Application:** Direct, objective SA measurement provides useful and diagnostic insights for research and design in a wide variety of domains and study objectives.

- **Keywords:** situation awareness, metrics, SAGAT, SPAM, measurement

**Lin Lu, Fadel M. Megahed, Lora A. Cavuoto. *Interventions to Mitigate Fatigue Induced by Physical Work: A Systematic Review of Research Quality and Levels of Evidence for Intervention Efficacy.* pp. 151–191**

**Objective:** We present a literature review on workplace physical fatigue interventions, focusing on evaluating the methodological quality and strength of evidence. **Background:** Physical fatigue is a recognized workplace problem, with negative effects on performance and health-related complaints. Although many studies have focused on the mechanisms and consequences of fatigue, few have considered the effectiveness of interventions to mitigate fatigue. **Method:** A systematic review of the workplace safety literature for controlled trials of physical fatigue interventions was conducted. Data on intervention type, subject characteristics, targeted tasks and body locations, outcome measures, and study design were extracted. The methodological quality for each study was evaluated using the PEDro scale, and the level of evidence was based on quality, amount, and consistency. **Results:** Forty-five controlled trials were reviewed, examining 18 interventions. We categorized those interventions into individual-focused ( $N = 28$  studies, nine interventions), workplace-focused ( $N = 12$  studies, five interventions), and multiple interventions ( $N = 5$  studies, four interventions). We identified moderate evidence for interventions related to assistive devices and task variation. There was moderate evidence supporting no fatigue attenuation for the garment change category of interventions. The interventions in the remaining categories had limited to minimal evidence of efficacy. The heterogeneity of the included trials precludes the determination of effect size. **Conclusion:** This review showed a lack of high levels of evidence for the effectiveness of most physical fatigue interventions. **Application:** Due to a lack of high levels of evidence for any category of reviewed physical fatigue interventions, further high-quality studies are needed to establish the efficacy of others.

- **Keywords:** ergonomic modifications, fatigue management, musculoskeletal disorders, recovery, occupational safety