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Jackie D. Zehr, Danielle R. Carnegie, Timothy N. Welsh & Tyson A. C. Beach. *A comparative analysis of lumbar spine mechanics during barbell- and crate-lifting: implications for occupational lifting task assessments.* Pages: 1-8.

Purpose. To compare the effects of object handled and handgrip used on lumbar spine motion and loading during occupational lifting task simulations. *Methods.* Eight male and eight female volunteers performed barbell and crate lifts with a pronated (barbell) and a neutral (crate) handgrip. The mass of barbells/crates lifted was identical across the objects and fixed at 11.6 and 9.3 kg for men and women, respectively. The initial heights of barbells/crates were individualized to mid-shank level. Body segment kinematics and foot-ground reaction kinetics were collected, and then input into an electromyography-assisted dynamic biomechanical model to quantify lumbar spine motion and loading. *Results.* Lumbar compression and net lumbosacral moment magnitudes were 416N and 17Nm lower when lifting a barbell than when lifting a crate ($p < 0.001$), respectively. There were no between-condition differences in lumbar flexion displacements ($p > 0.392$) or flexion/extension velocities ($p > 0.085$). *Conclusions.* Crate- and barbell-lifting tasks can be used interchangeably if assessing lifting mechanics based on peak spine motion variables. If assessments are based on the spine loading responses to task demands, however, then crate- and barbell-lifting tasks cannot be used interchangeably.

- **Keywords:** lower back loading, manual materials handling, perception, motor behavior

Hürmüs Kuzgun & Yıldız Denat. *The manual dexterity of nursing students and factors that affect it.* Pages: 9-14.

Aim. The purpose of this study was to define the manual dexterity of nursing students and factors that affect it. *Methodology.* The sample for this descriptive and analytical study was composed of 196 nursing students. The data collection tools were a survey and the Purdue pegboard test. *Results.* The mean dominant hand dexterity score of the students was determined to be 19.16 ± 1.36 ; non-dominant hand dexterity score, 17.04 ± 1.43 ; mean both hands dexterity score, 14.58 ± 1.35 ; mean right hand + left hand + both hands dexterity score, 50.70 ± 4.20 ; and mean assembly skill score, 38.55 ± 6.02 . As a result, manual dexterity of the nursing students is relatively high in

the 4th year of their education. Also, the students who have a normal body type, a hobby or have chosen the profession voluntarily have better manual dexterity scores. *Conclusion.* The results of the present study demonstrate that students should be guided to a hobby and adapted to the profession during nursing education. This study may constitute normative data for future study related to this issue, and may be guiding in the achievement of the objectives of nursing training and provision of a higher quality education.

- **Keywords:** nursing education, nursing students, manual dexterity, Purdue pegboard test

Tzu-Hsien Lee. *Muscular activity and acceleration of box vibration in manual holding tasks: effects of load and height of the load's center of gravity.* Pages: 15-19.

This study recruited 14 participants to examine the effects of load and height of the load's center of gravity (COG) on muscular activities of the brachioradialis, biceps brachii and erector spinae, and on box vibration acceleration (g) in manual holding tasks. Each participant was asked to hold a box in 12 conditions (4 loads × 3 heights of the load's COG). The results showed that muscular activities of the brachioradialis, biceps brachii and erector spinae significantly increased with load; however, they were not affected by the height of the load's COG. In addition, box vibration acceleration increased with load, and decreased with the height of the load's COG. The interaction effect of load and height of the load's COG on box vibration acceleration was also significant. This study recommends that the load magnitude should be decreased for the holding task that requires low vibration.

- **Keywords:** vibration, load, holding

Yung-Hsiang Cheng & Hui-Ning Tian. *Train drivers' subjective perceptions of their abilities to perceive and control fatigue.* Pages: 20-36.

Issues about train driver fatigue are important in the safety of railway systems. This study investigates the subjective perception of fatigue of conventional railway system drivers. The multidimensional Rasch model was used to measure two subjective latent constructs, namely, perceived fatigue awareness and perceived fatigue control. Analytical results show that 21% of the train drivers are unable to control fatigue. Randomly assigned vehicles with various cabin control systems for work shifts is the most unlikely scenario for drivers to perceive and control fatigue. Our results demonstrate that a driver who is unmarried, holds a university degree and has limited driving experience exhibits a low perceived ability to control fatigue. Thus, segmented programs for fatigue risk mitigation should be developed for specific drivers. The findings of this study can help railway safety managers and government regulators in developing and evaluating a management system for driver fatigue risk.

- **Keywords:** train drivers, railway system, subjective fatigue perception, multidimensional Rasch model, fatigue risk management system

Jing Dai, Min Luo, Wendong Hu, Jin Ma & Zhihong Wen. *Developing a fatigue questionnaire for Chinese civil aviation pilots.* Pages: 37-45.

Objective. To assess the fatigue risk is an important challenge in improving flight safety in the aviation industry. The aim of this study was to develop a comprehensive fatigue risk management indicators system and a fatigue questionnaire for Chinese civil aviation pilots. *Methods.* Participants included 74 civil aviation pilots (all males). They finished the

questionnaire in 20 min before a flight mission. Estimation of internal consistency with Cronbach's α and Student's t test as well as Pearson's correlation analysis were the main statistical methods. *Results.* The results revealed that the fatigue questionnaire had acceptable internal consistency reliability and construct validity; there were significant differences in fatigue scores between international and domestic flight pilots. Also, some international flight pilots, who had taken medications as a sleep aid, had worse sleep quality than those who had not. Long-endurance flights across time zones caused significant differences in circadian rhythm. *Conclusions.* The fatigue questionnaire can be used to measure Chinese civil aviation pilots' fatigue, which provides a reference for a fatigue risk management system for civil aviation pilots.

- **Keywords:** fatigue, aviation safety, civil aviation pilots, flight fatigue, fatigue risk management system

Nini Ma, Yehu Lu, Fanfei Xu & Hongqin Dai. *Development and performance assessment of electrically heated gloves with smart temperature control function.* Pages: 46-54.

A pair of lightweight electrically heated gloves (EHG) with smart temperature control function was developed. To evaluate the thermoregulation properties of the EHG, human trials were conducted in a climate chamber (2.5 °C, 60% RH). The changes in skin temperature at all fingers and the opisthenar, and the subjective thermal sensation were recorded over 60 min. The effects of two air velocities (i.e., 0.17 and 0.50 m/s) on the cold protective performance of the EHG in scenarios of heating and control were also investigated. For heating scenarios, skin temperature and thermal sensation at all fingers and the opisthenar were found significantly higher than those in control conditions. Moreover, the air velocity at 0.50 m/s greatly reduced the cold protective performance of the gloves. The research findings can be applied to improve thermal comfort and extend working times for persons in cold environments.

- **Keywords:** protective gloves, smart electrically heated, cold protective performance, local thermal sensation, local thermal comfort

Dipayan Das, Awadhesh Kumar & Monica Sharma. *A systematic review of work-related musculoskeletal disorders among handicraft workers.* Pages: 55-70.

Purpose. Handicraft manufacturing appears to be an occupation where work-related musculoskeletal disorders (WMSDs) are a major threat to workers. For the multifactorial nature and varying prevalence of WMSDs between different body areas, the current study aimed to evaluate the prevalence of WMSDs and associated risk factors among handicraft workers. *Methods.* This review was based on literature collected from three electronic databases, and the retrieved articles were screened following the inclusion/exclusion criteria. After applying the literature selection criteria to 182 articles, 30 citations were selected and examined in detail. *Results.* The findings suggest that the prevalence of musculoskeletal symptoms among handicraft workers is 38.5–100%, and the most affected body areas were the neck, back, knees and upper limbs. Risk factors including working posture, daily working hours, repetitive and forceful movements, work experience, age, gender and working under stressful conditions were found to be highly associated with the occurrence of WMSDs. However, higher educational qualification of the workers led to a reduction in the odds of developing WMSDs. *Conclusion.* Handicraft workers are at high risk of developing WMSDs. Further research, preferably longitudinal studies, with more emphasis on work-related factors should now be undertaken to thoroughly investigate WMSDs in this occupational group.

- **Keywords:** work-related musculoskeletal disorders, handicraft workers, prevalence, risk factor, ergonomics

Sajad Zare, Naser Hasheminejad, Mokhles Bateni, Mohammad Reza Baneshi, Hossein Elahi Shirvan & Rasoul Hemmatjo. *The association between wet-bulb globe temperature and other thermal indices (DI, MDI, PMV, PPD, PHS, PSI and PSIhr): a field study.* Pages: 71-79.

The current study aimed at comparing the correlation coefficients between wet-bulb globe temperature (WBGT) and a number of parameters, including the discomfort index (DI), modified discomfort index (MDI), predicted mean vote (PMV), predicted percentage of dissatisfaction (PPD), predicted heat strain (PHS), physiological strain index (PSI) and physiological strain index heart rate (PSIhr). In total, 30 workers of a pelletizing factory participated in this study. Environmental parameters and workers' physiological parameters were measured in 10 working stations. The results showed that effective WBGT (WBGT_{eff}) strongly correlates with DI, MDI, PMV, PPD, PHS, PSI and PSIhr. WBGT_{eff} had the highest correlation coefficients with PMV, MDI, PHS and PSIhr. Based on the obtained results, it was concluded that heat stress exceeded the standard limit for a number of indices in some of the working stations. Thus, some controlling measures should be taken to reduce heat stress in these stations.

- **Keywords:** heat, thermal stress, thermal indices, dry temperature, wet-bulb globe temperature

Chunlin Wu, Xiaowei Luo, Tao Wang, Yue Wang & Bibek Sapkota. *Safety challenges and improvement strategies of ethnic minority construction workers: a case study in Hong Kong.* Pages: 80-90.

Due to cultural differences, ethnic minority construction workers are more difficult to manage and more vulnerable to accidents. This study aims to identify the major barriers faced by ethnic minority workers from their own perspectives and to determine potential strategies to enhance the safety climate of construction projects, thus ultimately improving their safety performance. A survey with the modified nordic safety climate questionnaire was conducted for a certain subcontractor in Hong Kong. In-depth interviews, status quo description, major challenge investigation and safety knowledge tests were also carried out. The top three most important safety challenges identified were improper stereotypes from the whole industry, lack of opportunities for job assignment and language barriers. To improve the safety performance, employers should allocate sufficient personal protective equipment and governments should organize unannounced site visits more frequently. Also, the higher-level management should avoid giving contradictory instructions to foremen against the standards of supervisors.

- **Keywords:** ethnic minority workers, construction safety, safety climate, safety challenges, safety improvement strategies

Kyung-Sun Lee & Myung-Chul Jung. *Effect of hand postures and object properties on forearm muscle activities using surface electromyography.* Pages: 91-100.

Introduction. The objective of this study was to measure the effect of hand postures and object properties on nine forearm muscle activities and their contribution using surface electromyography. *Methods.* Ten male university students participated in the experiment. The objects used were cylindrical and rectangular, with lengths and weights of 2, 4, 6 and 8 cm and 400, 800, 1400 and 1800 g. The experimenter told the participant to pick up the object using a particular hand posture, lift the object to approximately shoulder height and maintain this posture for 3 s. *Results.* The hand posture, object size and object weight greatly influenced the muscle activities, but the object shape did not. Pinching with two or three fingers yielded the greatest muscle activities with the 8-cm, 1800-g object. The extensor pollicis longus and flexor pollicis longus muscles exhibited

the highest submaximal voluntary contraction. *Conclusion.* This study provides basic information about the specific activities of the forearm muscles and the effects of the hand postures and object properties on those activities.

- **Keywords:** pinching, grasping, percentage of maximal voluntary contraction, contribution, surface electromyography

Qiang Mei, Qiwei Wang, Suxia Liu, Qiaomei Zhou & Jingjing Zhang. *Effects of organizational safety on employees' proactivity safety behaviors and occupational health and safety management systems in Chinese high-risk small-scale enterprises.* Pages: 101-111.

Based on the characteristics of small-scale enterprises, the improvement of occupational health and safety management systems (OHS MS) needs an effective intervention. This study proposed a structural equation model and examined the relationships of perceived organization support for safety (POSS), person-organization safety fit (POSF) and proactivity safety behaviors with safety management, safety procedures and safety hazards identification. Data were collected from 503 employees of 105 Chinese high-risk small-scale enterprises over 6 months. The results showed that both POSS and POSF were positively related to improvement in safety management, safety procedures and safety hazards identification through proactivity safety behaviors. Our findings provide a new perspective on organizational safety for improving OHS MS for small-scale enterprises and extend the application of proactivity safety behaviors.

- **Keywords:** perceived organization support for safety, person-organization safety fit, prosocial and proactive safety behaviors, high-risk small-scale enterprises

Mikael Widell Blomé, Jonas Borell, Carita Håkansson & Kerstin Nilsson. *Attitudes toward elderly workers and perceptions of integrated age management practices.* Pages: 112-120.

This qualitative study investigates attitudes toward elderly workers and their work situation in different sectors, and explores perceptions and organizational measures that can enable an extended working life. Previous age management studies indicate that there are several interconnected measures and key areas of importance, and that there is a general need for strategies to strengthen sustainable age management at the organizational level. A structured content analysis was used to analyze data from focus group interviews with informants from a variety of organizations. The study identified three themes that highlight attitudes and perceptions of integrated age management practices: (a) contemporary policies and practices in the work environment; (b) social participation and attitudes; (c) experience and mentorship. These themes can form the basis of a good approach to an integrated age management strategy. Such a strategy can be achieved through intervention studies where research on sustainable working life meets the real problems faced by employees and managers.

- **Keywords:** age management, older workers, sustainable working life, work environment

Fatimazzahra Elmoujaddidi & Aziz Bachir. *Perceived risk, safety climate and safety behavior on Moroccan construction sites.* Pages: 121-128.

In Morocco, the construction sector is very dynamic economically, but suffers from weak safety performance. The few available statistics about the rates of occupational injuries and fatalities point to an alarming situation. However, root causes are yet to be identified. To fill this gap in knowledge, we conducted this study using an exploratory approach. Literature review, onsite observations and a survey were conducted to gather

information about safety and risk aspects on construction sites. We conducted a series of correlation tests and a regression analysis using IBM SPSS version 20. The results showed that: (a) there is a relatively strong risk perception bias among workers, with an underestimation of risk severity and occurrence probability; (b) risk perception was not found to predict safety behavior; (c) a positive safety climate seems to neutralize the negative impact that high risk tolerance had on safety behavior.

- **Keywords:** safety climate, risk perception, safety behavior, construction site, Morocco

Chrystal Joseph, Ayana U. C. Walters, Wendy L. Lawrence & Nigel Kevin Jalsa. *An ergonomic evaluation of pannists*. Pages: 129-139.

Instrumentalists and specifically percussionists have been found to develop musculoskeletal disorders (MSDs) due to the nature of their work. This study aimed to assess the MSD risk factors associated with playing the steel pan, which was invented in Trinidad and Tobago in the 20th century. A sample of 13 pannists and 13 non-pannists completed a modified Nordic Musculoskeletal Questionnaire and data analysis included multiple correlations, Student's t test, the Moore-Garg strain index and calculation of compressive force at the L5/S1 vertebrae. The prevalence of pain was found to be greater among the pannists; a strain index of 22.78 was calculated and the compressive force was determined to be 4507.8 N, which indicated that pannists have a high risk of developing MSDs of the upper limbs and lower back. The risk factors identified for the development of MSDs were similar to those of previous studies.

- **Keywords:** pannist, steel pan, instrumentalist, ergonomics, musculoskeletal disorders, Nordic questionnaire, Trinidad and Tobago

Linda Schenk, Karin Feychting, Anita Annas & Mattias Öberg. *Calls made to the Poisons Information Centre reveal need for improved risk management of cleaning agents in the workplace*. Pages: 140-148.

Purpose. This study aimed to investigate chemical injuries caused by cleaning agents and disinfectants by reviewing poison control data. *Methods.* We performed a 5-year retrospective analysis of calls to the Swedish Poisons Information Centre (PIC) concerning occupational use of cleaning agents and disinfectants. In addition, callers for 17 new cases were interviewed. *Results.* Out of 8240 occupationally related cases handled by the PIC during 2010–2014, 24% concerned cleaning agents and disinfectants ($N=1983$). Of these, one-third were classified as major risk cases, generally due to potential for corrosive eye and skin injuries. The most frequent type of workplace was restaurants and caterers. However, information about occupation was only identifiable for 30% of the cases. Follow-up interviews exemplify how limited awareness of safety data sheets and disregard of protective equipment may contribute to health-related outcomes such as absence at work. *Conclusions.* Management and prevention strategies for cleaning agents should be improved. PIC records hold relevant information both for designing interventions and for future research on occupational health and safety management. We suggest that systematic collection by the PIC of information on occupation and age would further improve the usefulness for occupational injury surveillance purposes.

- **Keywords:** caustics, hazardous substances, occupational health and safety, poison control centres, workplace injury

Sara Bragança, Ignacio Castellucci, Eric Costa, Pedro Arezes & Miguel Carvalho. *Anthropometric data for wheelchair users: a systematic literature review*. Pages: 149-172.

The wheelchair user population has special requirements that should be met. However, existing anthropometric data for this specific population are limited. This article characterizes and compares the available literature on anthropometric data of wheelchair users to allow for better understandings and use of data in future studies. A systematic literature review was conducted, where inclusion and exclusion criteria were defined. Forty-one articles were selected to be included in this review. The results show that there is limited information available on wheelchair users' anthropometrics. There is a lack of consistency between studies, regarding the measurements collected, samples used and methods applied. These methodological issues and differences between studies make it difficult to ensure good comparisons of databases and populations and proper designs of spaces and equipment. This study provides valuable information for future studies that need to use anthropometric data, for research and development of new products targeting wheelchair users.

- **Keywords:** anthropometry, disability, mobility impairment, body size, inclusivity

Jon Ingulf Medbø, Asgeir Mamen, Harald Oseland & Erna Dianne von Heimburg. *The steady-state load of five firefighting tasks*. Pages: 173-180.

Purpose. Physiologic demands of five common tasks in firefighting have been examined. *Methods.* Eight male volunteers, dressed up as smoke divers (+21 kg extra load), carried out the following tasks at constant pace for 5 min: walking at $1.4 \text{ m}\cdot\text{s}^{-1}$, walking (all walks at the same speed) while carrying a 10-kg ladder, walking carrying two hose packs of 16 kg together, walking carrying a 32-kg spreader tool and, finally, climbing up and down a ladder at a preset pace. A 5-min break separated each exercise. The heart rate, oxygen uptake and lung ventilation were measured continuously, and the blood lactate concentration was recorded after each task. *Results.* The end-exercise heart rate rose from 108 to 180 bpm from the first to last task, blood lactate concentration rose from 1 to $7 \text{ mmol}\cdot\text{L}^{-1}$, oxygen uptake rose from 19 to $48 \text{ ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$ and lung ventilation rose from 38 to $124 \text{ L}\cdot\text{min}^{-1}$. *Discussion.* Walking was an easy task even when dressed up as a smoke diver. Adding loads increased demands; ladder climbing taxed >90% of the subjects' aerobic power. *Conclusions.* The physiologic demands varied considerably between different tasks.

- **Keywords:** firefighting, ladder climbing, exercise, heart rate, oxygen uptake, lung ventilation, blood lactate concentration, rating of perceived exertion

Angelika Hauke, Eva Flaspöler & Dietmar Reinert. *Proactive prevention in occupational safety and health: how to identify tomorrow's prevention priorities and preventive measures*. Pages: 181-193.

Introduction. Global trends such as digitalization, globalization and demographic change are changing workplaces, and accordingly occupational safety and health (OSH) needs. To better prepare for the future and to foster proactive prevention, the German Social Accident Insurance (DGUV) established an OSH risk observatory (RO OSH). *Methods.* The RO OSH relies on an online survey and calls upon the expertise of labour inspectors. In total, 398 labour inspectors participated in the first RO OSH enquiry. They rated developments with regard to their sector-specific relevance for OSH in the near future. The RO OSH also provides ideas for preventive measures that can be implemented by the German Social Accident Insurance Institutions. *Results.* Work intensity, demographic aspects and digitalization play a major role for most or all sectors. However, familiar OSH issues such as musculoskeletal strain and noise also continue to be of major importance and require further consideration and specific solutions in prevention. *Outlook.* For the DGUV, training and consulting have great potential for proactive prevention in these priority areas, e.g., by fostering a prevention culture and supporting companies in (psychosocial) risk assessment (also for mobile work). For instance, concepts for

increasing physical activity at sedentary workplaces and data security require continued research.

- **Keywords:** risk observatory, German Social Accident Insurance, forecast, future, OSH

Kristen A. Rost & Alicia M. Alvero. *Participatory approaches to workplace safety management: bridging the gap between behavioral safety and participatory ergonomics*. Pages: 194-203.

Many researchers and practitioners argue the importance of end-user involvement in workplace safety management, but the research literature and practices remain fractured across orientations. The primary aim of this article is to bridge the gap between two major participatory safety management approaches: behavioral safety and participatory ergonomics. First, an overview and brief history of participative management is presented to provide context for its application to workplace safety. Next, behavioral safety and participatory ergonomics are separately examined in terms of their origins and core elements. Finally, based on this examination, unifying elements between behavioral safety and participatory ergonomics will be presented to provide a comprehensive account of participatory safety management.

- **Keywords:** behavioral safety, participatory ergonomics, safety management, end-user involvement, safety participation, participative safety approach

Cody E. Morris, Lee J. Winchester, Andrew J. Jackson, Ariel S. Tomes, Wesley A. Neal, Damon M. Wilcoxon, Harish Chander & Scott W. Arnett *Effect of a simulated tactical occupation task on physiological strain index, stress and inflammation*. Pages: 204-209.

Background. This study aimed to evaluate the physiological strain index (PSI) along with specific immune system markers in response to a simulated firefighting occupation workload. *Methods.* Ten healthy male adults completed a 6-min simulated fire stair climb (SFSC) at 60 steps/min. The protocol consisted of four conditions, some including wearing a 34.04-kg vest to simulate personal protective equipment (PPE) and/or inclusion of a color-word interference test (CWIT) as a distracting mechanism. The PSI was evaluated by continuously monitoring the heart rate and core temperature. Salivary cortisol (CORT) was measured at baseline, mid SFSC and post SFSC. C-reactive protein (CRP) was evaluated at baseline and 1 h post SFSC. *Results.* Repeated-measures analysis of variance showed a significantly different PSI across conditions ($p = 0.001$). A significantly elevated PSI was exhibited during all 6 min of SFSC for both PPE and PPE + CWIT conditions. Neither CORT ($p = 0.116$) nor CRP ($p = 0.700$) was significantly different across conditions or from baseline. *Conclusion.* These findings suggest that firefighters are potentially at a substantial degree of physiological stress from exercise and the weight of gear alone. Further work should be conducted to further evaluate the usefulness of the PSI as a means to monitor firefighters during fire suppression.

- **Keywords:** Firefighting, occupational ergonomics, tactical performance, applied physiology

Agnieszka Ćwirlej-Sozańska, Anna Wilmowska-Pietruszyńska, Bernard Sozański & Agnieszka Wiśniowska-Szurlej. *Assessment of disability and incidence of chronic diseases in employed and unemployed people aged 60–70 years living in Poland: a cross-sectional study*. Pages: 210-218.

Purpose. This study aimed to compare the level of disability and occurrence of chronic diseases in employed and unemployed people aged 60–70 years living in the society in

the southeastern part of Poland (Podkarpackie region). *Materials and methods.* A cross-sectional study of 1000 randomly selected people (aged 60–70 years) was performed. The World Health Organization disability assessment schedule questionnaire and a metric questionnaire were used. *Results.* Only 9.20% of people were employed, more often men and those with tertiary/vocational education. The level of disability was significantly lower in employed people than in unemployed people ($p = 0.023$). There were significant differences in favor of employed people concerning mobility ($p < 0.001$), participation in social life ($p = 0.002$), ability to perform normal household activities ($p = 0.006$) and self-service activities ($p = 0.026$). Unemployed people showed increased times of incapacity for their usual activities/work compared to employed people. *Conclusions.* In Poland, people aged 60–70 years who remain in the labor market have lower levels of disability, fewer chronic diseases, tertiary education (or vocational education) and higher income levels than those who are unemployed.

- **Keywords:** disability, elderly, employed, unemployed, World Health Organization disability assessment schedule 2.0, Poland