

International Journal of Occupational Safety and Ergonomics – rok 2021, ročník 27

Číslo 4



Nívia Cecília Kruta de Araújo, Fernanda Cabegi de Barros, Cristiane Shinohara Moriguchi & Tatiana de Oliveira Sato. *Comparison of two methods of sorting recyclable materials on posture among trash sorters in Brazil: a cross-sectional study.* Pages: 957-962.

Objective. The aim of the present study was to compare postural exposure between two methods of sorting recyclable materials: manual sorting on a fixed work surface and the use of conveyor belts. *Materials and methods.* Postures and movements of the head, upper back and upper arms were recorded during 2 h among 40 workers using inclinometers. Sociodemographic variables were collected with the aid of a standardized questionnaire and musculoskeletal symptoms were evaluated using the Nordic musculoskeletal questionnaire. *Results.* The angular velocity of the head, upper back and upper arms was significantly higher when sorting on a fixed work surface compared to the conveyor belt method. Upper arm elevation was also higher on the fixed work surface. *Conclusion.* The conveyor belt method showed lower angular velocities during the manual sorting of recyclable materials compared to a fixed work surface.

- **Keywords:** musculoskeletal pain, work organization, technical measurements, ergonomics, workload

Elżbieta Łastowiecka-Moras. *Standing and sitting postures at work and symptoms of venous insufficiency – results from questionnaires and a Doppler ultrasound study.* Pages: 963-969.

Chronic venous insufficiency is the most common vascular disease. One of the major risk factors for its development is long-term sitting or standing in the same position and the nature of the work performed. This study aimed to evaluate the incidence of chronic venous insufficiency in a group of persons employed in workplaces with a predominance of standing or sitting positions, and to determine work-related and non-work risk factors. The research used two tools: questionnaires and medical examinations. The survey comprised 500 people, including 238 men (47.6%) and 262 women (52.4%), aged 25–60 years, 39.75 ± 10.80 years old on average. In addition, a group of 100 randomly selected people was subjected to medical examinations to confirm or exclude chronic venous insufficiency symptoms in the study group. The study showed a statistically significant correlation between postures adopted at work and the symptoms of chronic venous insufficiency of the lower limbs.

- **Keywords:** chronic venous insufficiency of the lower limbs, occupational factors, work in the standing position, work in the sitting position, non-work factors, Doppler ultrasound

Dorota Racziewicz, Iwona Bojar & Ewa Humeniuk. *Work ability, functional exercise capacity and prevalence of obesity in perimenopausal and postmenopausal women with non-manual employment. Pages: 970-978.*

Objective. This study aimed to evaluate work ability and functional exercise capacity, and their correlation to each other and to obesity, in perimenopausal and postmenopausal women with non-manual employment. *Materials and methods.* The study included 300 women aged 44–66 years. The following measures were used: work ability index (WAI), 6-min walk test (6MWT), body mass index (BMI), waist–hip ratio (WHR) and adipose tissue accumulation. Regression models of the WAI and distance in the 6MWT were estimated. *Results.* The examined women obtained WAI 39.0 ± 5.0 , BMI 26.2 ± 4.6 , WHR 0.819 ± 0.060 and adipose tissue accumulation $30.1 \pm 6.1\%$, on average. About 19% of women obtained a very good work ability score, 55% good, 23% medium and 3% poor. About 17% of women were obese, 39% overweight and 44% normal body mass, 29% had abdominal obesity, 19% had elevated accumulation of adipose tissue and 21% had high accumulation of adipose tissue. These results did not differ significantly between perimenopausal and postmenopausal women. The postmenopausal women obtained a significantly lower functional exercise capacity score than perimenopausal women. *Conclusion.* Work ability correlates positively to functional exercise capacity, which correlates negatively to adipose tissue accumulation in perimenopausal women with non-manual employment, but not in postmenopausal cases.

- **Keywords:** 6-min walk test, functional exercise capacity, obesity, perimenopause, postmenopause, work ability index

Shuyu Shao, Qianxiang Zhou & Zhongqi Liu. *Study of mental workload imposed by different tasks based on teleoperation. Pages: 979-989.*

To explore mental workload and methods for dynamically monitoring mental workload imposed by complex tasks, this study constructed a virtual operating environment according to three cognitive steps: perception, judgment-making and action execution. Dynamic characteristics of mental workload were then analyzed employing subjective questionnaires, performance data and electroencephalography (EEG) characteristics. The analysis of non-linear dynamic characteristics of EEG signals showed that the fractal box dimension features of EEG signals are quite sensitive to the level of mental workload, exercising a significant impact on the four brain areas. The sample entropy is also quite sensitive to the level of mental workload, exercising a significant impact on the frontal, central and occipital areas. Based on this study, operational tasks can be dynamically assigned according to the state of personnel load and the safety and efficiency of the operation of the human–machine system can be ensured.

- **Keywords:** mental workload, teleoperation, electroencephalogram, non-linear dynamics, performance

Elena Stefana, Filippo Marciano, Paola Cocca, Diana Rossi & Giuseppe Tomasoni. *Oxygen deficiency hazard in confined spaces in the steel industry: assessment through predictive models. Pages: 990-1004.*

Objective. In the steel industry, performing activities in confined spaces where potential oxygen displacement can occur may expose workers to fatal consequences. To the best of our knowledge, no quantitative exposure assessment of oxygen deficiency in steel

industry confined spaces is available in the literature. To overcome this gap, we performed oxygen deficiency hazard (ODH) assessments in real confined spaces using two existing models to identify the most critical parameters responsible for ODH, and suggest controls for mitigating the asphyxiation risk. *Methods.* We applied a well-mixed model and a near field–far field approach to estimate the indoor oxygen level with time during and following release of simple asphyxiants. Model inputs were mainly gathered thanks to audits and instrumental tests in three firms. *Results.* The most severe ODH exposures are posed in spaces with restricted volume and where accidental releases of inert gases can occur. Such exposures can be controlled through early release detections and augmented reality systems. *Conclusions.* ODH assessments in confined spaces of steel firms allow the identification of the most critical parameters from an oxygen depletion perspective, focusing on which data need careful measurement, and help to establish controls compatible with the operations conducted in these areas.

Keywords: oxygen depletion, oxygen displacement, asphyxiation risk, inert gas, argon, furnace, welding, steel industry

Emil Kozłowski & Rafał Młyński. *The influence of frequency component content on the selection result of hearing protectors.* Pages: 1005-1018.

Hearing protectors are selected for workstation noise using the octave band (OB), HML and SNR methods. The purpose of this study was to determine how the frequency components of the noise can affect the selection of hearing protectors. In total, 55 hearing protectors were selected for four types of real occurring noise, high-frequency noise, low-frequency noise and eight simulated noises. Analysis showed that the noise type affects the accuracy of selection carried out using the HML and SNR methods. For a noise with dominant frequency components, the result for selection carried out using the HML method deviates from the result using the OB method by 7 and 9 dB for earmuffs and earplugs, respectively. The study shows that use of the HML and SNR methods may lead to wrong assessment of the effectiveness of hearing protection with the selected hearing protectors.

- **Keywords:** selection of hearing protectors, earmuffs, earplugs, sound attenuation, noise

Michail Karakikes & Dimitris Nathanael. *Development and testing of a wearable wrist-to-forearm posture measurement system for hand-tool design evaluation.* Pages: 1019-1027.

This study reports on the development and testing of a wearable wrist-to-forearm angle-measurement system for flexion/extension and radial/ulnar deviation of the wrist, and pronation/supination of the forearm. The system is based on inertial sensors and a microcontroller mounted on a glove and a forearm pad. The developed system was tested through the comparison of two off-the-shelf screwdrivers, one long and one short. Twelve male subjects participated in a within-subject experimental design test and performed a horizontal and a vertical screwing task for each screwdriver. Results indicated that the use of a long screwdriver causes significantly higher ulnar deviation of the wrist in both set-ups, while the short screwdriver promotes higher wrist extension in both set-ups. Clarity of the obtained results indicates that the proposed system is adequate for ergonomics studies on hand-tool design evaluation, while it addresses common pitfalls of other motion-capture methods.

- **Keywords:** wrist, forearm, posture, inertial, wearable, tool design, screwdrivers

Ahmed Wassiem, Gehan Raafat Zaki, Fahmy Charl & Ragaa El-Gazzar. *Biochemical changes among municipal solid waste sorting workers:*

implications for personal protective equipment availability and use. Pages: 1028-1038.

Background. Solid waste management has emerged as one of the greatest challenges facing human and environmental health. Municipal solid waste workers are potentially exposed to a variety of occupational biohazards and safety risks in the workplace. *Objective.* This study aimed to evaluate the availability and use of personal protective equipment (PPE) and some biochemical changes among solid waste sorting workers. *Methods.* A group of solid waste sorting workers was interviewed and checked for availability, use and appropriateness of PPE using a structured questionnaire and checklist. Workers were tested for hepatic and renal function parameters and biomarkers of allergy and inflammation. *Results.* The level of high-sensitivity C-reactive protein (hsCRP) as a biomarker of inflammation was elevated in 12.9% while total serum immunoglobulin E was obviously high among most workers (79.2%). Workers with inadequately available, used or effective PPE were more likely to have morbidities and showed elevated serum levels of serum glutamic pyruvic transaminase, serum glutamic-oxaloacetic transaminase, urea, creatinine, hsCRP and total immunoglobulin E. *Conclusions.* Elevated biomarkers of allergy and inflammation herald preclinical disease risks that should be included in basic health surveillance. Use of PPE should be emphasized for workers involved in solid waste sorting to effectively protect their health.

- **Keywords:** municipal solid waste, sorting workers, personal protective equipment, biochemical changes

Hadi Daneshmandi, Alireza Choobineh, Haleh Ghaem & Najmeh Hejazi. Proper sit-stand work schedule to reduce the negative outcomes of sedentary behavior: a randomized clinical trial. Pages: 1039-1055.

Objective. This study aimed to recommend an appropriate sit-stand schedule among office workers. *Methods.* The participants were randomly allocated into Time Regime 1 (TR1), Time Regime 2 (TR2) and Control (C) groups. A sit-stand workstation was provided to the TR1 and TR2 groups. The following variables were assessed: energy and macronutrients, energy expenditure in the workshift, blood parameters, depression, musculoskeletal symptoms, fatigue, productivity, workstation comfort and acceptability of the sit-stand workstation. *Results.* The results showed a significant increase in energy expenditure in the TR1 and TR2 groups in comparison to the C group. After the intervention, the highest prevalence of musculoskeletal symptoms in the shoulders, wrists/hands, and ankles/feet was related to the TR1 group, which was significantly different from the TR2 and C groups. Additionally, the 'severity of depression' was reduced significantly in the TR1 and TR2 groups compared to the C group. The scores for 'total fatigue' and its subscales were also reduced in the TR2 group. Furthermore, TR2 improved 'total productivity' and some of its subscales. Moreover, TR2 had a higher acceptability compared to TR1. *Conclusions.* TR2 had a positive effect on the office workers' energy expenditure, blood parameters, depression, fatigue and productivity.

- **Keywords:** Health outcomes, office workers, sedentary behavior, sit-stand workstation, work schedule

Kamila Nowak & Barbara Łukomska. The impact of shift work on the well-being and subjective levels of alertness and sleepiness in firefighters and rescue service workers. Pages: 1056-1063.

Shift work can be associated with health and sleep problems, which may lead to cognitive impairment. This study investigated the effects of shift work on sleep, health behaviours and cognitive functions of Polish rescue service workers. We tested 18 paramedics working 12-h shifts, 15 firefighters working 24-h shifts and 17 daytime workers. We

measured general sleepiness, workload during shifts and the occurrence of health behaviours. Additionally, we measured attention, executive function and subjective alertness. Paramedics showed lower average sleep duration and quality, and fewer health behaviours than firefighters and the control group. However, no differences were found in performance on cognitive tests between the groups and between the measures. The results indicate that the differences in job specificity may contribute to the effects of shift work on the sleep and health of the workers.

- **Keywords:** fatigue, shift work, sleep, alertness, cognitive functions

Shengyu Guo, Jichao Li, Kongzheng Liang & Bing Tang. *Improved safety checklist analysis approach using intelligent video surveillance in the construction industry: a case study.* Pages: 1064-1075.

The construction industry is extremely high risk, and safety checklist analysis is a widely used approach for safety assessment. To overcome its limitations, this article proposes an improved safety checklist analysis approach using intelligent video surveillance to replace on-site inspection. Then, a case study on metro tunnel construction is adopted to illustrate the process. First, the checklist is prepared. Second, the inspection items are correlated with construction areas, and intelligent cameras are positioned to cover the major areas of the construction site to guarantee that all the items can be checked. Thus, problems with inspection items are automatically identified and recorded. Third, the inspection items are marked by a remote scoring mechanism for safety assessment. Finally, the efficiency of the improved approach is tested by a comparative analysis among three groups. The application results indicate the feasibility of the improved approach for evaluating the safety management performance at construction sites.

- **Keyword:** occupational safety, safety checklist analysis, intelligent video surveillance, safety inspection, construction

Dragan Igić, Milovan Vuković, Snežana Urošević, Ivana Mladenović-Ranisavljević & Danijela Voza. *The relationship between ethical leadership, organizational commitment and Zero Accident Vision implementation in the defense industry.* Pages: 1076-1086.

The main aim of this research was to measure workers' perceptions of the four crucial success factors (commitment to safety, safety communication, the safety climate and learning from incidents) for Zero Accident Vision (ZAV) implementation by conducting a survey using a questionnaire given to four production plants in the Serbian military industrial complex. Almost 500 respondents participated in this survey with a response rate of over 90%. A possible influence of ethical leadership at work (ELW) and organizational commitment (OC) on ZAV enforcement was also examined. The reliability and validity of all of the measuring instruments were found to be acceptable. ELW was found to have a strong influence on ZAV implementation, whereas OC was found to have the mediating role in this relationship.

- **Keywords:** defense industry, Zero Accident Vision success factors, ethical leadership at work, organizational commitment, structural equation modeling

Mohammed Muzafar. *Building information modelling to mitigate the health and safety risks associated with the construction industry: a review.* Pages: 1087-1095.

As the construction industry continues to develop across the world, it is crucial that the industry begins to integrate digital technologies into all aspects of design, planning, construction, maintenance and even demolition of construction projects. This review

explores the current use of this technology to help mitigate risks on site with a focus on proactive design rather than reactive mitigations, with the aim of directing further research on the topic to help improve the health and safety record in construction. A variety of literature was reviewed specifically relating to the integration of building information modelling into construction alongside an array of construction safety literature. Integrating these two strands of literature has allowed for the suggestion of new practical methods of recording and presenting health and safety information by facilitating a risk identification process that assigns assets with hazards and mitigations.

- **Keywords:** building information modelling, health and safety, heat map, risk ranking, health hazards, safety planning

Jhilly Dasgupta & Pranab Kumar Nag. *Climate-induced thermoregulatory responses in a non-linear thermal environment: investigating the inter-dependencies using a facile artificial neural network-based predictive strategy.* Pages: 1096-1107.

Objectives. Given the burgeoning impacts of climatic variability on human health, suitable computational paradigms are used to explore the subsequent ergonomic repercussions. The artificial neural network (ANN), in particular, exhibits near-accurate input-output mapping. However, employment of the ANN to trace the inter-dependencies between the climatic and human thermoregulatory parameters in real-world fuzzy problem landscapes is relatively inadequate. In the present study, the ANN models examined the relationships between climatic, behavioral and intrinsic input factors and the thermoregulatory outputs, namely, sweating and the evaporative heat transfer at the skin surface (E_{sk}). *Methods.* The data were obtained from nearly 1800 subjects who were exposed to a hot and humid climate outdoors. The ANN models were trained using the Levenberg–Marquardt algorithm combined with Bayesian regularization. *Results.* The predictability of the ANN models was statistically substantiated. The clothing insulation factor was not included as an input parameter, given its similar values. Intriguingly, the ANN results indicated that fabrics with similar thermal resistances could still affect E_{sk} , plausibly owing to the temporal variation in the evaporative resistance of fabrics among individuals. *Conclusion.* The reasonably accurate results affirmed the suitability of ANN as a pragmatic technique that could elucidate heat-induced ergonomic challenges.

- **Keywords:** Thermoregulatory responses, environmental ergonomics, evaporative resistance, artificial neural network, Levenberg–Marquardt algorithm, Bayesian regularization

Marzena Malińska, Joanna Bugajska & Paweł Bartuzi. *Occupational and non-occupational risk factors for neck and lower back pain among computer workers: a cross-sectional study.* Pages: 1108-1115.

Objectives. The aim of this study was to identify major determinants for neck and lower back pain (LBP) among office workers of different ages. *Methods.* Computer workers ($N = 2000$) responded to a questionnaire on demographics, musculoskeletal disorders (MSDs), lifestyle characteristics, ergonomics of computer work and psychosocial and physical job characteristics. *Results.* Over 48% of respondents complained of MSDs last year, in particular neck pain and LBP. The results of logistic regression analysis revealed that prolonged computer time (odds ratio [OR] 1.92) and increased job demands (OR 1.06) were likely to increase the risk of neck pain, while social support (OR 0.96) and the use of seat-plate height adjustment (OR 0.64) would help to reduce the risk. Risk factors for LBP included smoking more than 14 cigarettes a day (OR 2.21), long hours spent working with a computer (OR 1.94), increased physical exertion at work (OR 1.29), increased work demands (OR 1.03) and older age (OR 1.03). *Conclusions.* The most effective way to eliminate MSD hazards in the workplace is to develop health

programmes aimed at advocating healthy lifestyle behaviours and raising workers' awareness of workstation ergonomics and work organization, especially for women and older workers.

- **Keywords:** musculoskeletal disorders, spinal pain syndrome, lower back pain, neck pain, computer workers, ergonomics of computer work

In-Ju Kim. *Hospital flooring safety and health: knowledge gaps and suggestions.* Pages: 1116-1135.

Fall incidents are a leading safety concern in the hospital industry. Whereas roughening the floor surface can reduce fall risks, there remains unanswered controversies between achieving and maintaining hygienic cleaning efficiencies and adequately addressing conditions of flooring safety. Thus, the current study critically overviews the status of research and accepted practices on hospital flooring safety and healthy controls. Salient literature was identified by searching keywords and phrases within the databases of PubMed, Web of Science, MEDLINE, Scopus and ScienceDirect to find answers for the major questions on hospital floorings. A comprehensive review analysis identified that underlying causes of hospital fall incidents and flooring-attributable infectious illnesses mainly comprised floor types and materials, cleaning chemicals, materials and methods, maintenance and slip-resistance properties. Findings from this study suggest several major actions to advance hospital flooring safety and health research and practice.

- **Keywords:** hospital fall incidence, hospital floor hygiene, hospital floor infection, hospital floor safety, hospital safety and health

Isabel Moreira-Silva, Joana Azevedo, Sandra Rodrigues, Aderito Seixas & Mota Jorge. *Predicting musculoskeletal symptoms in workers of a manufacturing company.* Pages: 1136-1144.

Background. Musculoskeletal symptoms are the leading factor responsible for sickness absence. Factors associated with the development of musculoskeletal symptoms must be identified and addressed. *Objective.* To investigate the 7-day prevalence of musculoskeletal symptoms by body regions, and assess the contribution of individual, lifestyle and occupational risk factors to the development of musculoskeletal disorders. *Methods.* The sample comprised 202 white-collar and blue-collar workers. Musculoskeletal symptoms were assessed with the Nordic questionnaire, and physical activity level and sitting time with the international physical activity questionnaire. Statistical analyses were conducted to assess the associations between individual, lifestyle and occupational category factors and musculoskeletal symptoms. *Results.* The 7-day prevalence of work-related musculoskeletal symptoms was 41.6% ($n = 84$). The highest prevalence of symptoms was reported in the lower back (18.8%), followed by the wrists/hands (17.3%), neck (15.8%), shoulder (15.3%) and ankles/feet (11.4%). A significant association was found between reporting musculoskeletal symptoms and work category. In addition, musculoskeletal symptoms were reported more often by older workers. Work category was a significant predictor of pain in the lower back and shoulder regions, and gender was a significant predictor for neck pain. *Conclusions.* Our results emphasize the need for worksite interventions to prevent musculoskeletal symptoms in this population.

- **Keywords:** musculoskeletal pain, risk factors, blue-collar workers, white-collar workers

Soqrat Omari Shekaftik, Azadeh Ashtarinezhad, Farshad H. Shirazi, AghaFatemeh Hosseini & Rasoul Yarahmadi. *Assessing the risk of main*

activities of nanotechnology companies by the NanoTool method. Pages: 1145-1153.

Purpose. Nanotechnology can be considered one of the greatest developments over the past few decades. Despite many applications of nanomaterials in various fields, there are concerns about their effects on humans and the environment. Therefore, this study was conducted to assess the risk level of activities involving nanomaterials in nanotechnology companies in Tehran, Iran. *Materials and methods.* After identifying the main activities of 18 nanotechnology companies, these activities were assessed using the NanoTool method, which is a method for assessing risks of activities involving nanomaterials. Data were analyzed using SPSS version 22. *Results.* The results showed that in six activities (33.30%) the risk level was 4 (RL4), in eight activities (44.40%) the risk level was 3 (RL3) and four activities (22.30%) had risk level 2 (RL2). Also, it was found that 78.88% of the controls used by these companies were not enough to reduce the risks of nanomaterials and need to be upgraded. *Conclusions.* The high level of risk in the activities involving nanomaterials shows that there are serious problems regarding the safety of nanomaterials in the nanotechnology companies in Tehran, Iran.

- **Keywords:** nanomaterials, NanoTool method, occupational exposure, risk assessment

Suxia Liu, Xu Yang & Qiang Mei. The effect of perceived organizational support for safety and organizational commitment on employee safety behavior: a meta-analysis. Pages: 1154-1165.

Recently, the significance of organizational support and commitment in workplace safety has gained much recognition. The improvement of individual safety behavior needs more convincing and effective evidence. This study constructed a comprehensive theoretical model and used meta-analysis to examine the relationships between perceived organizational support for safety, organizational commitment and employee safety behavior. Support was found for the study's hypothesis that both perceived organizational support for safety and organizational commitment have a positive association with employee safety behavior, with the latter demonstrating the stronger relationship. However, organizational commitment was not mediated by perceived organizational support for safety and employee safety behavior. Results show that the safety behavior of employees in general industries and developed regions is more vulnerable to perceived organizational support for safety and organizational commitment than that in high-risk industries and developing regions. The implications of the findings and suggestions for further research are discussed.

- **Keywords:** perceived organizational support for safety, organizational commitment, employee safety behavior, meta-analysis

Miao Tian & Jun Li. A method to predict burn injuries of firefighters considering heterogeneous skin thickness distribution based on the instrumented manikin system. Pages: 1166-1178.

An approach was proposed to predict skin burns during heat exposure based on computational fluid dynamics and Python language. Both uniform and heterogeneous skin thickness distributions of the whole body were considered and significant differences were observed. 100% second-degree burns were reached for the uniform skin model after 4-s flash fire, and maintained during the cooling phase. Third-degree burns occurred for the heterogeneous skin model during fire exposure, and the proportion increased in the cooling phase. Results indicated that the model with uniform skin thickness probably overestimates skin burns in the early stage of fire exposure. The prediction at the latter stage of the model with heterogeneous skin thickness tended to

be more serious. Ignoring blood perfusion and dynamic thermophysical parameters of the skin model was the limitation of this study. Nevertheless, this method provides the basis for further advancements in thermal protective ensembles, to enhance occupational safety of firefighters.

- **Keywords:** firefighters, burn injuries, skin thickness, fire exposure, thermal protective clothing

Wouter M.P. Steijn, Dolf van der Beek, Jop Groeneweg, Anne Jansen, Wieke A. Oldenhof & Ingrid Raben. *Towards the next generation of LMRA instruments: the influence of generic and specific questions during risk assessment.* Pages: 1179-1192.

Last minute risk assessment (LMRA) is a well-known work method to support employees' risk perception. However, little is known about the effectiveness of LMRA in providing this support. Here, we describe an eye-tracking experiment with which we attempted to gain more insight into the relationship between LMRA and risk perception and to assess the difference between generic and specific supporting questions. Employees from an international energy production and desalination company participated in this experiment by assessing photographs portraying a (staged) work situation and deciding whether it was safe enough to continue activities and which risk factors were present or absent. The results show a consistent interaction effect over several parameters between work experience and the type of supporting questions, indicating that generic and specific supporting questions should be considered complimentary to each other. Furthermore, the results revealed several other challenges concerning real-world application of the LMRA.

- **Keywords:** last minute risk assessment, eye tracking technology, risk perception, risk assessment

Filiz Ozdemir & Seyma Toy. *Evaluation of scapular dyskinesia and ergonomic risk level in office workers.* Pages: 1193-1198.

Purpose. The purpose of this study is to evaluate the association between ergonomic risk level and scapular dyskinesia in office workers. *Methods.* This cross-sectional study included office workers aged 20–65 years. A lateral scapular slide test (LSST) was used to evaluate scapular dyskinesia, and the quick exposure check (QEC) method was used to analyze the ergonomic risk level. *Results.* In all, 37 (45.7%) participants were men and 44 (54.3%) participants were women. Of the participants with scapular dyskinesia in any of the three LSST positions, 10.3% had low, 20.6% had medium, 30.9% had high and 37.9% had very high ergonomic risk level ($p = 0.001$). A low, positive linear correlation was observed between ergonomic risk level and LSST-1, LSST-2 and LSST-3 values. *Conclusion.* These results indicate that patients with scapular dyskinesia have a high ergonomic risk level. We believe that our work will serve as a foundation for intervention studies assessing ergonomic risk management.

- **Keywords:** ergonomic riskscapular dyskinesiawork-related musculoskeletal disorders

Dariusz Pleban, Jan Radosz, Leszek Kryst & Jolanta Surgiewicz. *Assessment of working conditions in medical facilities due to noise.* Pages: 1199-1206.

Factors related to the working environment (e.g. inadequate lighting, excessive noise, poor condition of premises) contribute to neglect in the work of medical personnel, while also causing health effects in their body. This article presents the results of the

assessment of working conditions in workplaces at selected medical facilities in Poland. This assessment was based on survey results. The survey was conducted by means of a questionnaire among more than 300 physicians, nurses and diagnostic laboratory staff. The average grading of noise annoyance in workplaces on a scale from 0 to 10 was 2.77, and therefore noise was assessed as a slight inconvenience.

- **Keywords:** noise, hospital, workplace, annoyance

Hsin Hung Tu, Victor Ei Wen Lo, Chien Wei Liu, Yung Ping Liu, Chi Yuang Yu, Chih Yong Chen & Li Wen Liu. *Body volume estimation equation for male laborers in Taiwan.* Pages: 1207-1214.

The purpose of this study was to develop a body volume (BV) estimation equation for male laborers in Taiwan with body weight (W) and stature height (H) as initial estimators. A three-dimensional (3D) body scanner and a 3D foot scanner were used to measure the 3D range data of 100 male laborers in this study. Subjects' BV was extracted from the 3D body model, and H and W were used as independent variables in regression analysis. The results show that the final BV estimation equation is $BV = 1122.927 \times W^{0.972}$, with $R^2 = 0.949$. Thirty extra male subjects were scanned to compare this BV estimation equation with those in previous studies. The results show that this BV estimation equation had the smallest absolute mean difference at 1.1458 L and the smallest standard error of the estimate at 2.48% in comparison.

- **Keywords:** body volume, three-dimensional scanner, estimation equation, male laborers

Sunisa Chaiklieng, Pornnapa Suggaravetsiri & Jenny Stewart. *Incidence and risk factors associated with lower back pain among university office workers.* Pages: 1215-1221.

This prospective cohort study investigated the incidence of lower back pain (LBP) and the risk factors for LBP among university-based office workers. Participants were 159 office workers in one Thailand university who met the inclusion criteria of the cohort group. Data were collected using a follow-up interview questionnaire and measurements of physical fitness and lighting intensity. Results showed that the incidence of LBP during 12-month follow-up was 83.0%. Physical fitness tests showed that the back, leg and hand grip strengths were significantly lower in LBP cases than in non-cases. Multiple logistic regression analysis indicated that the risk factors associated with LBP were body mass index ≤ 25 (adjusted relative risk [RRadj] = 3.49, 95% confidence interval [CI] [1.27, 9.55]), poor back-pain preventive behavior (RRadj = 3.44, 95% CI [1.08, 10.98]) and inappropriate workstation width (RRadj = 5.72, 95% CI [1.44, 22.70]). In conclusion, most workstations (91.8%) had a lighting intensity lower than the standard requirement (400–500 lx). The results indicate the nature of hazards affecting LBP in office workers in the academic workplace. In order to prevent LBP in this group of office workers, ergonomics education and the better design of workspace, improved lighting and greater emphasis on the physical fitness of staff are needed.

- **Keywords:** incidence, lower back pain, physical fitness, office workers, risk factor

Gholam Abbas Shirali & Maryam Malekzadeh. *Classification and quantification of human error in air traffic control: a case study in an airport control tower.* Pages: 1222-1234.

This study aims at exploring human error in an airport control tower through the technique for the retrospective and predictive analysis of cognitive error (TRACEr) and the controller action reliability assessment (CARA) method. Despite the presence of

automated safety nets, air traffic control (ATC) is heavily dependent upon the capabilities of humans. A number of ATC-relevant accidents were characterized by human errors. The data related to error dimensions were collected through interview and direct observation. Then, human error probability and error-producing conditions were evaluated by the CARA method. The results showed that selection and quality, memory, distraction/preoccupation, and traffic and airspace have the highest percentage error rates. Furthermore, the results indicated that the highest probability of error was associated with emergency situation management. This study is the first research to classify and quantify human errors using the TRACER and the CARA method to evaluate controller error in ATC.

- **Keywords:** human error air traffic control, human error probability, technique for the retrospective and predictive analysis of cognitive error, controller action reliability assessment

Valeria Villani, Lorenzo Sabattini, Dorota Żołnierczyk-Zreda, Zofia Mockało, Paulina Barańska & Cesare Fantuzzi. *Worker satisfaction with adaptive automation and working conditions: a theoretical model and questionnaire as an assessment tool.* Pages: 1235-1250.

This article focuses on methods and tools to measure worker satisfaction with reference to industrial automation. Despite technological advances in automation, the role of human workers on industrial shop floors remains crucial. To promote humans' roles, production systems should be designed and organized so workers are valued and get satisfactory jobs. The article presents a novel holistic model of worker satisfaction with adaptive automation and working conditions. The model takes into account psychosocial and physical working conditions and the characteristics of the automation system the worker interacts with and its user interface. We propose a questionnaire to be used as a practical tool to assess worker satisfaction with industrial automation, considering also the case of adaptive automation. The proposed version of the questionnaire is the result of pilot testing carried out among shop floor operators and takes into account adjustments derived from end-user feedback.

- **Keywords:** worker satisfaction, industrial automation, adaptive automation, questionnaire for worker satisfaction, inclusive work environment, anthropocentric automation

Silke Heuse, Babette Gekeler & Daniel Fodor. *The role of physical exercise as a personal resource against job stress.* Pages: 1251-1260.

Purpose. The prevention of burnout symptoms is an essential goal in occupational health promotion. Physical exercise provides health-promotion benefits. This study aimed to verify physical exercise and its planned preparation as additional predictors of employees' burnout symptoms next to job demands and resources. We used the job demands-resources model as a theoretical framework. *Method.* In this longitudinal online study, 342 employees completed two questionnaires at an interval of 4 weeks. *Results.* Moderation and moderated mediation analyses confirmed vigorous physical exercise as a relevant personal resource, revealing that it buffers the detrimental effects of job demands on burnout symptoms. Planning strategies strongly predicted physical exercise and supported the debilitating effects of job resources on burnout symptoms. Especially in employees with medium levels of job stress, coping planning supported the enactment of vigorous physical exercise. Physical exercise did not mediate the association between job demands, job resources and burnout symptoms. *Conclusions.* This study enriches our knowledge about occupational health prevention. It points to a pressing topic for the near future, i.e., how work conditions (e.g., job stress) and leisure time (e.g., physical exercise) can be successfully combined to keep individuals' job stress to a minimum and to prevent burnout symptoms.

- **Keywords:** job stress, burnout, physical exercise, action planning, coping planning, job demands–resources model

Zahra Jabbarani Torghabeh, Terry L. Stentz & Kelli Herstein.
Construction glass and glazing job description: a qualitative case study.
Pages: 1261-1270.

Construction workers regularly experience heavy workloads and various physical stressors that can result in work-related musculoskeletal disorders (WRMSDs). According to the Bureau of Labor Statistics, construction glass and glazing (CGG) workers had a higher rate of injuries and illnesses than the national average for all occupations. In 2010, CGG contractors presented the highest rate of back injuries reported by the Center for Construction Research and Training. This study aimed to develop a detailed job description that includes the CGG definition, tasks, activities and work conditions. A qualitative case study was conducted, and data were collected through CGG workers' interviews and observations. This information is not currently available in government publications, published research or job training materials for CGG workers and contractors. The results of this study can help facilitate the ergonomics analysis in future studies to eliminate or reduce the risk of WRMSDs in CGG work.

- **Keywords:** construction, glass and glazing work, job description, qualitative study, case study

David N. Naumann, Emma Toman, Conor Bentley & Alastair Beaven.
Depiction of personal protective equipment in popular war films.
Pages: 1271-1276.

Background. Personal protective equipment (PPE) is worn by military personnel to protect from combat trauma. War films may not represent PPE accurately, even when considered realistic. There is a risk that the subtle influence of films may subvert the understanding of PPE amongst military personnel and civilians. *Methods.* An observational study compared the depiction of PPE within popular war films to real-life. Films were included if they depicted land-based warfare. Depiction of helmets, body armour, eye protection, gloves, combat boots and hearing protection was compared to benchmarks. Trends in PPE over time were analysed using linear regression. *Results.* There were 73 combat scenes viewed from 16 films. Combat boots were the most depicted (72 scenes; 99%); hearing protection was the least (two scenes; 3%). There were statistically significant differences in PPE adherence between real life and films for all items of PPE ($p < 0.05$), except for combat boots ($p = 0.621$). There were improvements over time for all PPE except for hearing protection. *Conclusions.* PPE adherence in modern war films is poor, but has improved over time. There is a hypothetical risk that this has a negative impact on perceptions by both civilians and military personnel.

- **Keywords:** personal protective equipment, trauma, movies, films, injury, compliance