

International Journal of Occupational Safety and Ergonomics – rok 2017, ročník 23

Číslo 1



Daniel Podgórski, Katarzyna Majchrzycka, Anna Dąbrowska, Grzegorz Gralewicz & Małgorzata Okrasa. *Towards a conceptual framework of OSH risk management in smart working environments based on smart PPE, ambient intelligence and the Internet of Things technologies.* Pages: 1-20.

Recent developments in domains of ambient intelligence (AmI), Internet of Things, cyber-physical systems (CPS), ubiquitous/pervasive computing, etc., have led to numerous attempts to apply ICT solutions in the occupational safety and health (OSH) area. A literature review reveals a wide range of examples of smart materials, smart personal protective equipment and other AmI applications that have been developed to improve workers' safety and health. Because the use of these solutions modifies work methods, increases complexity of production processes and introduces high dynamism into thus created smart working environments (SWE), a new conceptual framework for dynamic OSH management in SWE is called for. A proposed framework is based on a new paradigm of OSH risk management consisting of real-time risk assessment and the capacity to monitor the risk level of each worker individually. A rationale for context-based reasoning in SWE and a respective model of the SWE-dedicated CPS are also proposed.

- **Keywords:** ambient intelligence, Internet of Things, smart working environment, occupational safety and health management, smart personal protective equipment, cyber-physical systems, real-time risk assessment, ubiquitous safety

Weidong Li, Shiqi Li, Yan Fu & Jacon Chen. *Effects of ladder parameters on asymmetric patterns of force exertion during below-knee amputees climbing ladders.* Pages: 21-32.

Different from walking, ladder climbing requires four-limb coordination and more energy exertion for below-knee amputees (BKAs). We hypothesized that functional deficiency of a disabled limb shall be compensated by the other three intact limbs, showing an asymmetry pattern among limbs. Hand and foot forces of six below-knee amputees and six able-bodied people were collected. Hand, foot and hand/foot sum force variances between groups (non-BKA, intact side and prosthetic side) were carefully examined. Our hypothesis was validated that there is asymmetry between prosthetic and intact side.

Results further showed that the ipsilateral hand of the prosthetic leg is stronger than the hand on the intact side, compensating weakness of the prosthetic leg. Effects of ladder rung separations and ladder slant on asymmetric force distribution of BKAs were evaluated, indicating that rung separation has a more significant interactive effect on hand/foot force of BKAs than ladder slant.

- **Keywords:** ladder climbing, hand force, foot force, below-knee amputee, asymmetry

Kimmo Vänni, Subas Neupane & Clas-Håkan Nygård. *An effort to assess the relation between productivity loss costs and presenteeism at work.* Pages: 33-43.

Purpose. This study assesses potential presenteeism costs and the association of these with a company's business figures. **Materials and methods.** We conducted the questionnaire surveys in alternate years between 2003 and 2007 and linked them to sickness absence register data. Perceived work ability levels were assessed and converted into presenteeism days using the Presenteeism Scale tool. Sickness absence and presenteeism days were converted into monetary figures using median monthly salary information. **Results.** The share of presenteeism costs was constant at about 1% of annual turnover and about 3.7% of personnel costs. The lowest annual presenteeism cost per employee was EUR 986 and the highest was EUR 1302. The lowest number of presenteeism days per employee in a year was 8.7 days and the highest number was 10.4 days. Estimated losses to a company due to sickness absences and presenteeism ranged from EUR 4.6 million to EUR 5.6 million annually. The potential presenteeism costs to the company and to Finnish society were vast. **Conclusions.** Presenteeism is a costly problem but more research is needed to reveal the connections between presenteeism and a company's turnover, personnel costs and profit.

- **Keywords:** presenteeism, productivity loss, assessment methods, work ability, costs, business profit

Corey A. Peacock, Raymond Weber, Gabriel J. Sanders, Yongsuk Seo, David Kean, Brandon S. Pollock, Keith J. Burns, Mark Cain, Phillip LaScola & Ellen L. Glickman. *Pilot physiology, cognition and flight performance during flight simulation exposed to a 3810-m hypoxic condition.* Pages: 44-49.

Background. Hypoxia is a physiological state defined as a reduction in the distribution of oxygen to the tissues of the body. It has been considered a major factor in aviation safety worldwide because of its potential for pilot disorientation. Pilots are able to operate aircrafts up to 3810m without the use of supplemental oxygen and may exhibit symptoms associated with hypoxia. **Objective.** To determine the effects of 3810 m on physiology, cognition and performance in pilots during a flight simulation. **Methods.** Ten healthy male pilots engaged in a counterbalanced experimental protocol comparing a 0-m normoxic condition (NORM) with a 3810-m hypoxic condition (HYP) on pilot physiology, cognition and flight performance. **Results.** Repeated-measures analysis of variance demonstrated a significant ($p \leq 0.05$) time by condition interaction for physiological and cognitive alterations during HYP. A paired-samples *t* test demonstrated no differences in pilot performance ($p \geq 0.05$) between conditions. **Conclusion.** Pilots exhibited physiological and cognitive impairments; however, pilot performance was not affected by HYP.

- **Keywords:** hypoxia, flight simulation, physiology

Christian Dagenais, Laurence Plouffe, Charles Gagné, Georges Toulouse, Andrée-Anne Breault & Didier Dupont. *Improving the health and safety of 911 emergency call centre agents: an evaluability assessment of a knowledge transfer strategy.* Pages: 50-59.

A knowledge transfer (KT) strategy was implemented by the IRSST, an occupational health and safety research institute established in Québec (Canada), to improve the prevention of psychological and musculoskeletal problems among 911 emergency call centre agents. An evaluability assessment was conducted in which each aspect of the KT approach was documented systematically to determine whether the strategy had the potential to be evaluated in terms of its impact on the targeted population. A review of the literature on KT in occupational health and safety and on the evaluation of such KT programmes, along with the development of a logic model based on documentary analysis and semi-structured interviews with key stakeholders, indicated that the KT strategy was likely to have had a positive impact in the 911 emergency call centre sector. Implications for future research are discussed.

- **Keywords:** evaluability assessment, knowledge transfer, occupational health and safety, emergency call centre agents

Kriengsak Panuwatwanich, Saeed Al-Haadir & Rodney A. Stewart. *Influence of safety motivation and climate on safety behaviour and outcomes: evidence from the Saudi Arabian construction industry.* Pages: 60-75.

Purpose. Over the last three decades, safety literature has focused on safety climate and its role in forecasting injuries and accidents. However, research findings regarding the relationships between safety climate and other key outcome constructs are somewhat inconsistent. Recent safety climate literature suggests that examining the role of safety motivation may help provide a better explanation of such relationships. The research presented in this article aimed to empirically analyse the relationships among safety motivation, safety climate, safety behaviour and safety outcomes within the context of the Saudi Arabian construction industry. **Method.** A conceptual model was developed to examine the relationships among four main constructs: safety motivation, safety climate, safety behaviour and safety outcomes. Based on the survey data collected in Saudi Arabia from site engineers and project managers ($n = 295$), statistical analyses were carried out, including confirmatory and exploratory factor analysis, and structural equation modelling to assess the model and test the hypotheses. **Results.** The main results indicated that safety motivation could positively influence safety behaviour through safety climate, which plays a mediating role for this mechanism. The results also confirmed that safety behaviour could predict safety outcomes within the context of the Saudi Arabian construction industry.

- **Keywords:** construction, safety behaviour, safety climate, safety motivation, Saudi Arabia

Byung Yong Jeong. *Occupational deaths and injuries by the types of street cleaning process.* Pages: 76-82.

This study aims to obtain an overall picture of occupational injuries by the types of street cleaning process. Three hundred and fifty-four injured persons were analyzed in terms of the company size and details of the injured persons and accidents. Results show that 'roadway cleaning' was the most common type of cleaning process for injuries, followed by 'sidewalk cleaning,' 'going/returning to work by bike' and 'lifting/carrying.' The findings also show that most accidents which occur when 'going/returning to work by bike' are in the form of traffic accidents, while in other processes they happen most often

in the form of slips. Most of the accidents related to 'lifting/carrying' affected workers in their 50s or younger while other processes had a large portion of injured persons in their 50s or older. The findings of this study can be used as baseline data for preventative policies.

- **Keywords:** street cleaner, occupational accident, street cleaning process, accident prevention

Javier Esquer, Jose Angel Arvayo, Clara Rosalia Alvarez-Chavez, Nora Elba Munguia-Vega & Luis Velazquez. *Cleaner production in a remanufacturing process of air compressors. Pages: 83-91.*

This article provides relevant results of a cleaner production program conducted in a company dedicated to remanufacturing air compressors in the city of Hermosillo, Sonora, Mexico. The overall study design was based on an integration of acknowledged cleaner production and pollution prevention programs. Although this kind of program also involves environmental issues, this study focused on occupational health and safety by addressing different aspects of the work environment: ergonomic, physical (noise and lighting), and chemical. Particularly, ergonomic aspects were evaluated through the Modular Arrangement of Predetermined Time Standards (MODAPTS) method. For physical aspects, noise and lighting were addressed through Standard No. NOM-011-STPS-2001 and Standard No. NOM-025-STPS-2008 respectively. In addition, chemical aspects were analyzed through material safety data sheets and different search tools. Root causes of each risk were identified, and options to prevent, eliminate, and/or reduce each risk have been provided.

- **Keywords:** cleaner production, remanufacturing, MODAPTS, Mexico, air compressors

Guohua Liang, Guomin Qian, Ye Wang, Zige Yi, Xiaolei Ru & Wei Ye. *Design of a 3-dimensional visual illusion speed reduction marking scheme. Pages: 92-104.*

To determine which graphic and color combination for a 3-dimensional visual illusion speed reduction marking scheme presents the best visual stimulus, five parameters were designed. According to the Balanced Incomplete Blocks–Law of Comparative Judgment, three schemes, which produce strong stereoscopic impressions, were screened from the 25 initial design schemes of different combinations of graphics and colors. Three-dimensional experimental simulation scenes of the three screened schemes were created to evaluate four different effects according to a semantic analysis. The following conclusions were drawn: schemes with a red color are more effective than those without; the combination of red, yellow and blue produces the best visual stimulus; a larger area from the top surface and the front surface should be colored red; and a triangular prism should be painted as the graphic of the marking according to the stereoscopic impression and the coordination of graphics with the road.

- **Keywords:** traffic safety, 3-dimensional visual illusion speed reduction marking, graphic and color combination, visual stimulus, Balanced Incomplete Blocks–Law of Comparative Judgment, semantic analysis

Grzegorz Gralewicz, Grzegorz Owczarek & Janusz Kubrak. *Analysis of the selected mechanical parameters of coating of filters protecting against hazardous infrared radiation. Pages: 105-109.*

This article presents a comparison of the test results of selected mechanical parameters (hardness, Young's modulus, critical force for delamination) for protective filters intended

for eye protection against harmful infrared radiation. Filters with reflective metallic films were studied, as well as interference filters developed at the Central Institute for Labour Protection – National Research Institute (CIOP-PIB). The test results of the selected mechanical parameters were compared with the test results, conducted in accordance with a standardised method, of simulating filter surface destruction that occurs during use.

- **Keywords:** mechanical parameters, coating of filters, optical filters, interference filters, reflective filters

Christopher Brandl, Alexander Mertens & Christopher M. Schlick. *Ergonomic analysis of working postures using OWAS in semi-trailer assembly, applying an individual sampling strategy.* Pages: 110-117.

In semi-trailer assembly, workers are exposed to several physical risk factors. Awkward working postures have not yet been investigated in semi-trailer assembly, although they are known to be a major risk factor for musculoskeletal disorders. We therefore conducted a comprehensive ergonomic analysis of working postures using the Ovako working posture analysing system (OWAS), with an individual sampling strategy. The postural load in semi-trailer assembly was assessed on the basis of 20,601 observations of 63 workers executing a representative set of nine work tasks. According to the OWAS, the postural load of various working postures and body part positions may have a harmful effect on the musculoskeletal system. We therefore give examples of corrective measures that could improve awkward working postures. Applying an individual sampling strategy was revealed to have advantages over a collective strategy, so this is recommended for future ergonomic analyses.

- **Keywords:** ergonomics, OWAS, postural load, semi-trailer assembly, working postures

Miao Tian, Huiju Park, Heekwang Koo, Qinwen Xu & Jun Li. *Impact of work boots and load carriage on the gait of oil rig workers.* Pages: 118-126.

Effects of work boots and load carriage (6.4 kg and 12.8 kg) on gait pattern were investigated. The protective work boots were examined by comparison with running shoes through human performance tests with 15 male participants. The loads were carried symmetrically and asymmetrically on the shoulder and hand. Statistical data analysis showed a prolonged stance phase and decreased double support for work boots. A significantly increased ground reaction force was found in work boot conditions as the weight of loads increases. This study demonstrates that inflexible and heavy work boots restrict foot movement and require greater torque at the ankle to propel the body forward, which may increase physical strain and the risk of musculoskeletal injuries. Development of improved fixation methods for work boots, increased use of flexible protective layers and further study of anthropometry of human foot morphology for improved safety and work efficiency of industry workers are suggested.

- **Keywords:** gait, load carriage, work boots

Kasumi Tsai, Tzu-Yin Lee & Min-Huey Chung. *Insomnia in female nurses: a nationwide retrospective study.* Pages: 127-132.

Objective. This study explored the incidence of insomnia in female nursing staff and compared the incidence with that in other medical and nonmedical female workers. **Methods.** This retrospective study analyzed female nurses with insomnia using data from January 1, 2004 to December 31, 2008. The incidence of insomnia in other

female medical workers and nonmedical female workers was also analyzed and compared with that of the nurses. Using the Taiwan National Health Insurance Research Database, each study patient was identified by ID number. The incidence and rate ratio of insomnia were calculated according to their outpatient claims. **Results.** Compared with other medical and nonmedical female workers, female nurses had higher incidences of adjustment insomnia and psychophysiological insomnia. However, female nurses had a lower incidence of nonorganic insomnia than did other female medical personnel. Older participants and those with the comorbidities of depressive and respiratory disorders had a higher risk of insomnia than did younger participants and those with other comorbidities. **Conclusion.** We suggest that nurses should be encouraged to relax in order to facilitate stress relief and improve their quality of sleep.

- **Keywords:** nurses, incidence, sleep, women's studies, workforce issues

Julian Bonello & Charles V. Sammut. *Experimental analysis of radiographer exposure to the static field from a 1.5-T magnetic resonance imaging machine.* Pages: 133-138.

Introduction. This study measures the exposure of occupational therapists from a 1.5-T magnetic resonance imaging (MRI) machine. **Method.** A total of 14 time-series on each of the chest, head and hand were taken before and after different MRI procedures. The peak values were noted in each case together with an average of all data recorded in the time-series. **Results.** The highest exposure recorded was observed on the hand, followed by the head and the chest. The overall maximum exposure (1479.40 mT) recorded was observed on the hand during a change of coil. It was also observed that the recorded exposure of experienced radiographers working in the MRI environment was less than that of junior staff due to different practices. **Conclusion.** This study is of significant importance in Malta since it is the first conducted in a MRI environment, especially because the results were compared with limits imposed by EU Directive 2013/35/EU which has to be implemented by July 2016.

- **Keywords:** magnetic resonance imaging, static magnetic field, radiographers, Directive 2013/35/EU, occupational exposure

Ole Jacob Møllerløyken, Helen Stavang & Kjell Hansson Mild. *Staff exposure to pulsed magnetic fields during depression treatment with transcranial magnetic stimulation.* Pages: 139-142.

Introduction. Transcranial magnetic stimulation or repetitive transcranial magnetic stimulation (TMS/rTMS) are currently used in research and treatments of diseases of the central nervous system, such as recurring depression. Strong electric pulses are used to produce strong pulsed magnetic fields that are directed to the patient's cerebral cortex where the fields induce electric pulses. The pulses may be causing unnecessary exposure of the staff. **Method.** The MagVenture TMS/rTMS system was investigated, without patient presence, through measurements of magnetic field pulses at varying distances from the emitting coil and different power settings (94–127 A/s). **Results.** Fourteen measurements were done which displayed exposures exceeding the given guidelines up until a distance of 40 cm from the transmitting coil. **Discussion.** The study shows that the exposure of staff in this type of treatment may exceed the given guidelines for occupational exposure, thus confirming previous findings. This necessitates good routines in information and treatment procedures to avoid this exposure.

- **Keywords:** occupational exposure, risk assessment, therapy

Kjell Hansson Mild, Stefan Friberg, Jennifer Frankel & Jonna Wilén.
Exposure to the magnetic field from an induction loop pad for a hearing aid system. Pages: 143-145.

As a case study we have measured the magnetic field from an induction loop pad designed for hearing aid assistance. The magnitude of the field was high, although well below international guidelines. We recorded values up to 70% of the recommended standard in some instances. However, in view of the many reports indicating health effects of low-level exposure, we recommend that the precautionary principle is applied when such pads are given to people who might be especially vulnerable, such as children, pregnant women and women on breast cancer medication.

- **Keywords:** hearing aid, cancer, reproduction, tamoxifen