

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

## Číslo 2



**Elżbieta Łastowiecka-Moras. *How posture influences venous blood flow in the lower limbs: results of a study using photoplethysmography.* Pages: 147-151.**

Prolonged standing or sitting is one of the factors for chronic venous insufficiency. The aim of the study was to determine the impact of static load of the lower limbs on the functioning of the venous system. The study included 10 healthy young participants, with no peripheral venous disease. All participants took part in examinations in two variants: variant 1, sitting for 20 min with the lower limbs bent in the knee joints at 90°; variant 2, standing for 20 min with no additional load. Before and after each test, the venous refilling time (VRT) was determined using photoplethysmography. Statistical analysis demonstrated that the VRT was significantly shortened only after application of variant 2. Furthermore, even variants with small loads applied to healthy young participants can induce in them effects on the parameters describing the peripheral circulation.

- **Keywords:** chronic venous insufficiency, lower limbs, occupational factors, posture, standing, sitting, Doppler ultrasound, photoplethysmography

**Melissa Jacobs & Jacobus Pienaar. *Stress, coping and safety compliance in a multinational gold mining company.* Pages: 152-161.**

The primary objective of this study was to investigate the relationship of work stress, consisting of role stressors and job insecurity, with safety compliance at work. A secondary objective was to test for the possible moderating effect of individual employees' coping behaviour between experienced work stress and job insecurity, and their safety compliance. A cross-sectional survey design was used ( $n=771$ ). An electronic survey, with a biographical questionnaire and scales on role conflict, role ambiguity, role overload, job insecurity, coping and safety compliance at work, was administered. The results indicated that specific aspects of work stress, notably role conflict, role ambiguity and quantitative job insecurity, and of coping, namely an avoidance style and changing the situation, were important in understanding safety compliance. A moderating effect of avoidance coping was also found.

- **Keywords:** work stress, qualitative and quantitative job insecurity, role ambiguity, role conflict, qualitative and quantitative role overload, coping, safety compliance

**Qing-Guang Liu, Qiang-Min Huang, Feng-Hu Wang & Shuai Fan. *Influence of trunk muscle activity and stability in front and back holding.* Pages: 162-168.**

**Purpose.** A tandem carrying style is often used in the workplace, but carrying approaches are different for two people because of the holding load in the tandem posture. To understand these carrying styles, this study aimed to investigate the patterns of muscle activity and stability of the trunk influenced by front and back holding of a heavy load. **Methods.** Electromyography data of eight trunk and two hip muscles, as well as displacements of the trunk, were recorded for analysis while subjects stood statically holding a handle in the front and back of the body with and without load. **Results.** Without load, muscle activities during front holding mirrored those during back holding. With load, greater muscle activities were observed in the dorsal muscles of the trunk and lesser activities were noted in the ventral muscles in the two holding styles. More frequencies of trunk oscillations occurred in front holding with and without load. **Conclusions.** The results revealed that back holding of load created more stability of the upper body, whereas front holding resulted in more instability of the trunk.

- **Keywords:** manual holding in front and back, load posture, electromyography, trunk oscillation

**Mansour Ziaei, Hojjat Ziaei, Seyed Younes Hosseini, Faramarz Gharagozlou, Ali Akbar Keikhamoghaddam, Marzieh Izadi Laybidi & Mehdi Moradinazar. *Assessment and virtual redesign of a manual handling workstation by computer-aided three-dimensional interactive application.* Pages: 169-174.**

**Background.** Manual handling of bags which imposes frequent forces and stresses on body parts is a common task that many workers have to perform every day. The present study aimed to assess the postural risk and imposed forces due to manual handling and loading of sugar bags. **Methods.** This study was conducted on male warehouse workers of a sugar manufacturing plant. Rapid upper limb assessment (RULA) was used to assess the risks of awkward postures and computer-aided three-dimensional interactive application to estimate the forces and moments. **Results.** RULA final scores were estimated to be 7 and 3 before and after the virtual redesign, respectively. Postures B and E obtained the highest compression forces and moments. The compression forces were higher than the action limit (AL) in all postures before the redesign and exceeded the maximum permissible limit (MPL) in posture E. After the redesign, these forces were reduced below the AL and MPL. Moreover, the shearing forces were lower than the AL and MPL in all postures. **Conclusions.** The main risk factors were heavy weight and poor control of sugar bags. Virtual redesign can diminish bending and twisting postures, and, therefore, some resulting forces and moments.

- **Keywords:** computer-aided three-dimensional interactive application, manual materials handling, workstation, sugar industry

**Michelle Cardoso, Michelle Girouard, Jack P. Callaghan & Wayne J. Albert. *An ergonomic evaluation of city police officers: an analysis of perceived discomfort within patrol duties.* Pages: 175-184.**

The purpose of this study was to assess the perceived discomfort of patrol officers related to equipment and vehicle design and whether there were discomfort differences between day and night shifts. A total of 16 participants were recruited (10 males, 6 females) from a local police force to participate for one full day shift and one full night shift. A series of questionnaires were administered to acquire information regarding comfort with specific car features and occupational gear, body part discomfort and health

and lifestyle. The discomfort questionnaires were administered three times during each shift to monitor discomfort progression within a shift. Although there were no significant discomfort differences reported between the day and night shifts, perceived discomfort was identified for specific equipment, vehicle design and vehicle configuration, within each 12-h shift.

- **Keywords:** perceived discomfort, ergonomics, police officers, vehicle design

**Michelle Cardoso, Michelle Girouard, Colin McKinnon, Jack P. Callaghan & Wayne J. Albert. *Quantifying the postural demands of patrol officers: a field study.* Pages: 185-197.**

Police officers are at high risk for developing musculoskeletal injuries. This study aimed to determine differences in physical demands of patrol officers during day shifts and night shifts. Sixteen participants were recruited (10 males, 6 females) for in-vehicle observation over one full day shift and one full night shift. Dynamic pressure distribution when seated in the vehicle was assessed and compared between the first and last parts of each shift. Activity characterization and postural analyses were conducted from video that was recorded continuously for the duration of each shift to determine time spent in each task and corresponding postures. Postural analysis and cumulative joint loads were used to identify higher-risk tasks. Several activities caused the officers to adopt non-neutral postures of the neck, shoulders and back. Future work needs to focus on modifying the interior of the vehicle, as well as decreasing exposure time to activities resulting in non-neutral postures.

- **Keywords:** ergonomics, postural assessment, police officers

**David J. Cornell, Stacy L. Gnacinski, Aaron Zamzow, Jason Mims & Kyle T. Ebersole. *Measures of health, fitness, and functional movement among firefighter recruits.* Pages: 198-204.**

**Aim.** The purpose of this study was to examine the associations between various health and fitness measures and Functional Movement Screen™ (FMS™) scores among 78 firefighter recruits. **Methods.** Relationships between FMS™ scores and age, body mass index (BMI), sit and reach (S&R) distance, estimated maximal aerobic capacity ( $\dot{V}O_{2max}$ ), estimated one-repetition maximum squat (1RM-Squat<sub>max</sub>), and plank endurance (%Plank<sub>max</sub>) were examined. **Results.** Total FMS™ scores were significantly correlated with BMI ( $r = -0.231, p = 0.042$ ), estimated 1RM-Squat<sub>max</sub> ( $r = 0.302, p = 0.007$ ), and %Plank<sub>max</sub> ( $r = 0.320, p = 0.004$ ). Multiple regression analyses indicated that this combination of predictors significantly predicted ( $F(3, 74) = 5.043, p = 0.003$ ) Total FMS™ score outcomes and accounted for 17% of the total variance ( $R^2 = 0.170$ ). In addition, logistic regression analyses indicated that estimated 1RM-Squat<sub>max</sub> also significantly predicted ( $\chi^2 = 6.662, df = 1, p = 0.010$ ) FMS™ group membership ( $\leq 14$  or  $\geq 15$ ). **Conclusion.** These results suggest that the health and fitness measures of obesity (BMI), bilateral lower extremity strength (estimated 1RM-Squat<sub>max</sub>), and core muscular endurance (%Plank<sub>max</sub>) are significantly associated with functional movement patterns among firefighter recruits. Consequently, injury prevention programs implemented among firefighter recruits should target these aspects of health and fitness.

- **Keywords:** Functional Movement Screen™, muscular strength, muscular endurance, obesity

**Darko Palačić. *The impact of implementation of the requirements of Standard No. OHSAS 18001:2007 to reduce the number of injuries at work and financial costs in the Republic of Croatia.* Pages: 205-213.**

This article contains the results of research into the impact of implementation of the requirements mentioned in Standard No. OHSAS 18001:2007 to reduce the number of injuries at work and the financial costs incurred in this way. The study was conducted on a determined sample by a written questionnaire survey method in the Republic of Croatia. The objective of the empirical research is to determine the impact of implementation of the requirements of Standard No. OHSAS 18001:2007 to reduce the number of injuries at work and financial costs in Croatia in business organizations that implement these requirements. To provide a broader picture, the research included the collection and analysis of data on the impact of the Standard No. OHSAS 18001:2007 on accidents and fatalities at work. Research findings are based on the analysis of performed statistical data where correlation and regression analysis has been applied.

- **Keywords:** injury at work, OHSAS 18001:2007, improvement, implementation, impact, costs

**Yong-Ku Kong, Andris Freivalds, Dae-Min Kim & Joonho Chang. *Investigation of methods for estimating hand bone dimensions using X-ray hand anthropometric data.* Pages: 214-224.**

This study examined two conversion methods, M1 and M2, to predict finger/phalange bone lengths based on finger/phalange surface lengths. Forty-one Korean college students (25 males and 16 females) were recruited and their finger/phalange surface lengths, bone lengths and grip strengths were measured using a vernier caliper, an X-ray generator and a double-handle force measurement system, respectively. M1 and M2 were defined as formulas able to estimate finger/phalange bone lengths based on one dimension (i.e., surface hand length) and four finger dimensions (surface finger lengths), respectively. As a result of conversion, the estimation errors by M1 presented mean 1.22 mm, which was smaller than those (1.29 mm) by M2. The bone lengths estimated by M1 (mean  $r = 0.81$ ) presented higher correlations with the measured bone lengths than those estimated by M2 (0.79). Thus, the M1 method was recommended in the present study, based on conversion simplicity and accuracy.

- **Keywords:** X-ray hand anthropometric data, finger/phalange bone lengths, finger/phalange surface lengths, estimation of finger/bone lengths, estimation error of finger bone lengths

**Simo Salminen, Pia Perttula, Henriikka Ratilainen & Eeva Kuosma. *The effect of demographic factors on occupational injuries.* Pages: 225-228.**

**Objectives.** In Finland about 120,000 occupational injuries occur annually, the cost of which is over EUR 2 billion per year. This is why it is reasonable to analyze the effect of demographic factors like gender, age, tenure and mother tongue on occupational injuries. **Methods.** The participants consisted of 1681 employees from four Finnish companies, who reported their injuries from the last 3 years. **Results.** Gender or mother tongue did not associate with injury involvement. Employees younger than 25 years of age were more often involved in injuries than employees aged over 55 (odds ratio [OR] = 2.69, 95% confidence interval [CI] [1.70, 4.23]). Employees with 2–10 years of experience in the company had a higher injury frequency than both novice and very experienced employees (OR = 2.01, 95% CI [1.60, 2.52]). **Conclusions.** This study showed that age was a more important factor in injury involvement than gender, tenure or mother tongue. However, age was closely related to experience in the company. Prevention measures in the companies should thus focus on novice employees.

- **Keywords:** gender, age, experience, mother tongue

**Isabelle Thouvenin, Françoise Bouneb & Thierry Mercier. *Operator dermal exposure and protection provided by personal protective***

**equipment and working coveralls during mixing/loading, application and sprayer cleaning in vineyards. Pages: 229-239.**

The efficiency of a working coverall combined with personal protective equipment to protect operators against dermal exposure to plant protection products under field conditions was studied. Operators wore a non-certified water-repellent finish polyester/cotton coverall plus a certified gown during the mixing/loading and the cleaning phases. Insecticide foliar application to a vineyard was selected as the exposure scenario. The overall dermal residue levels measured in this study were in the range of data recently collected in Europe. The water-repellent finish working coverall reduced body exposure by a factor of approximately 95%. Wearing a Category III Type 3 partial body gown during mixing/loading and cleaning of the application equipment led to a further protective effect of 98.7%. The combination of a water-repellent finish working coverall and partial body protection during specific tasks provided satisfactory levels of protection and can be considered as suitable protection for the conditions of use studied.

- **Keywords:** personal protective equipment, dermal exposure, pesticide, operator, vineyard, working coverall, partial body, foliar application

**Jesús A. Carrillo-Castrillo, Antonio F. Trillo-Cabello & Juan C. Rubio-Romero. Construction accidents: identification of the main associations between causes, mechanisms and stages of the construction process. Pages: 240-250.**

**Objective.** To identify the most frequent causes of accidents in the construction sector in order to help safety practitioners in the task of prioritizing preventive actions depending on the stage of construction. **Methods.** Official accident investigation reports are analysed. A causation pattern is identified with the proportion of causes in each of the different possible groups of causes. **Results.** Significant associations of the types of causes with accident mechanisms and construction stages have been identified. **Conclusions.** Significant differences have been found in accident causation depending on the mechanism of the accident and the construction stage ongoing. These results should be used to prioritize preventive actions to combat the most likely causes for each accident mechanism and construction stage.

- **Keywords:** causation patterns, accident investigation, construction sector, preventive actions

**Rashid Haidarimoghadam, Reza Kazemi, Majid Motamedzadeh, Rostam Golmohamadi, Alireza Soltanian & Mohamad Reza Zoghipaydar. The effects of consecutive night shifts and shift length on cognitive performance and sleepiness: a field study. Pages: 251-258.**

**Introduction.** The aim of this study was to evaluate the effects of consecutive night shifts (CNS) and shift length on cognitive performance and sleepiness. **Materials and methods.** This study evaluated the sleepiness and performance of 30 control room operators (CROs) working in 7 nights, 7 days, 7 days off (7N7D7O) and 30 CROs working in 4 nights, 7 days, 3 nights, 7 days off (4N7D3N7O) shift patterns in a petrochemical complex on the last night shift before swinging into the day shift. To assess cognitive performance, the *n*-back test, continuous performance test and simple reaction time test were employed. To assess sleepiness, the Karolinska sleepiness scale was used. **Results.** Both schedules indicated that the correct responses and response times of working memory were reduced ( $p = 0.001$ ), while intentional errors and sleepiness increased during the shift work ( $p = 0.001$ ). CNS had a significant impact on reaction time and commission errors ( $p = 0.001$ ). **Conclusion.** The main duty of CROs at a petrochemical plant is checking hazardous processes which require appropriate alertness and cognitive

performance. As a result, planning for appropriate working hours and suitable number of CNS in a rotating shift system is a contribution to improving CRO performance and enhancing safety.

- **Keywords:** consecutive night shift, performance, sleepiness

**Konstantinos Lazaridis, Jovica Jovanović, Jovana Jovanović, Ivana Šarac & Stefan Jovanović. *The impact of occupational stress factors on temporary work disability related to arterial hypertension and its complications.* Pages: 259-266.**

**Aim.** To determine which specific groups of occupational stress factors influence the duration of temporary work disability related to arterial hypertension and joint complications/co-morbidities. **Methodology.** Workers ( $n = 1398$ ; 1009 in the exposed group, 389 in the control group) with arterial hypertension who worked at one workplace for a minimum of 10 years were divided into 10 subgroups, depending on the presence of joint complications/co-morbidities. The intensity of seven groups of occupational stress factors, the total score of Occupational Stress Index (OSI) and the average number of lost working days during 1 year were analysed. **Results.** The number of lost working days due to arterial hypertension and joint complications/co-morbidities was significantly higher in the exposed group. In all subgroups of the exposed group there was a high correlation between the number of lost working days and the total OSI score. Specific occupational stress factors were associated with specific complications: High Demands with chronic myocardial infarction, Strictness with cerebral haemorrhage, Conflict/Uncertainty with cerebral infarction, Extrinsic Time Pressure with acute myocardial infarction, and Avoidance/Symbolic Aversiveness with non-insulin-dependent diabetes. **Conclusion.** There are specific groups of occupational stress factors which can influence the duration of work disability associated with certain complications and co-morbidities of arterial hypertension.

- **Keywords:** occupational stress factors, Occupational Stress Index, arterial hypertension, co-morbidity, lost working days

**Shunji Sako, Hiromichi Sugiura, Hironori Tanoue, Makoto Kojima, Mitsunobu Kono & Ryoichi Inaba. *Electromyographic analysis of relevant muscle groups during completion of computer tasks using different computer mouse positions.* Pages: 267-273.**

**Background.** We analyzed muscular activity for different computer mouse positions during the completion of a timed computer task and determined whether the different mouse positions could affect muscular activity, productivity and perceived fatigue. **Methods.** The subjects were nine healthy young men. Two mouse positions were studied: the distal position (DP), with the forearm rested on the desk; the proximal position (PP), with only the wrist rested on the desk. The subjects performed a 16-min task in each position. Surface electromyography data were recorded for the upper back and shoulder muscles. Work productivity and muscular activity were measured for each mouse position. A visual analog scale was used to assess subjective fatigue. **Results.** Muscular activity was higher in muscle (m.) deltoideus (posterior) for the DP, while it was significantly higher in m. inferior infraspinatus for the PP. The visual analog scale score was significantly higher and work productivity was lower in the PP. **Conclusions.** We found that using a mouse in the DP rather than the PP leads to less activity of the external rotators, less perceived fatigue and more productivity. This suggests that the DP is preferable to the PP for computer work involving a mouse.

- **Keywords:** computer operation, mouse position, muscular activity, perceived fatigue, repetitive stress injury

**Flavia D'Agostin & Corrado Negro. *Symptoms and musculoskeletal diseases in hospital nurses and in a group of university employees: a cross-sectional study.* Pages: 274-284.**

**Background.** Most studies have shown that nurses have a higher risk of developing musculoskeletal symptoms compared with other occupational groups. **Aim.** A cross-sectional study was performed to gain more insight into the prevalence rates of musculoskeletal disorders (MSDs) in nurses. **Methods.** The presence of musculoskeletal symptoms was revealed by personal interviews in a sample of 177 hospital nurses and in a reference group of 185 university employees. Musculoskeletal diseases were based on radiological examinations in all subjects. **Results.** Lower back pain (61% vs 42.2%) was the most frequently reported symptom, followed by neck pain (48.6% vs 38.4%) and shoulder pain (36.7% vs 25.9%), with a significantly higher prevalence in nurses. Women had about a 2-fold risk of upper limb region and neck pain compared with men. The most common abnormal findings on radiological examinations were disc herniations ( $n = 40$ ). **Conclusions.** Nurses showed a significantly higher risk of MSDs. Prevalence rates in nurses increased significantly with age. Musculoskeletal symptoms were also common in university employees. This suggests the need for effective intervention strategies involving workers' active participation, in order to improve the process and organization of work and promote a positive psychosocial work environment.

- **Keywords:** musculoskeletal disorders, nursing personnel, university employees, individual factors, multiple symptoms, radiological examinations

**Metin Bayram, Mustafa C. Ünğan & Kadir Ardiç. *The relationships between OHS prevention costs, safety performance, employee satisfaction and accident costs.* Pages: 285-296.**

Little is known about the costs of safety. A literature review conducted for this study indicates there is a lack of survey-based research dealing with the effects of occupational health and safety (OHS) prevention costs. To close this gap in the literature, this study investigates the interwoven relationships between OHS prevention costs, employee satisfaction, OHS performance and accident costs. Data were collected from 159 OHS management system 18001-certified firms operating in Turkey and analyzed through structural equation modeling. The findings indicate that OHS prevention costs have a significant positive effect on safety performance, employee satisfaction and accident costs savings; employee satisfaction has a significant positive effect on accident costs savings; and occupational safety performance has a significant positive effect on employee satisfaction and accident costs savings. Also, the results indicate that safety performance and employee satisfaction leverage the relationship between prevention costs and accident costs.

- **Keywords:** OHS costs, OHSAS 18001, employee satisfaction, safety performance