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**Morteza Cheraghi, Ali Bagherian-Sahlavani, Hedayat Noori & Iraj Mohammad-Fam. *Evaluation of hazard distances related to toxic releases in a gas refinery: comparison of chemical exposure index and consequence modeling approaches*. Pages: 641-653.**

The release of toxic chemicals is an important hazard of chemical plants. The purpose of this study is to compare the chemical exposure index (CEI) and consequence modeling to determine the hazard distance of toxic chemical release, utilizing a gas refinery as the case study. The CEI was utilized and considerable release scenarios were determined. The process hazard analysis software tool model was performed for consequence modeling of the scenarios with the highest airborne quantity. In the case of toxic chemical release based on both the CEI and consequence modeling, the sludge catcher unit was identified as the most dangerous unit. Hazard distances calculated by the CEI are significantly greater than those using consequence modeling. This is acceptable in terms of safety, but may not be applicable in reality. The results of the study showed a procedure for selecting an appropriate method in order to reduce costs and time.

- **Keywords:** hazard distance, gas refinery, consequence modeling, chemical exposure index

**Yaser Shokouhi, Parvin Nassiri, Iraj Mohammadfam & Kamal Azam. *Predicting the probability of occupational fall incidents: a Bayesian network model for the oil industry*. Pages: 654-663.**

*Purpose.* The probability of being injured or killed from an occupational incident is much higher than a process mishap in the oil and gas industry. The aim of this study was to establish a model for predicting the probability of occupational fall incidents using Bayesian networks. *Methods.* The study was performed in a selected number of oil refineries. Bayesian network variables ( $n = 18$ ) were identified using literature as well as expert knowledge. These contributing factors were categorized into four layers (organizational, supervisory, preconditions and unsafe acts) according to the Swiss cheese model. Causal relationships among contributing factors were determined using expert judgment in combination with Dempster-Shafer theory. The conditional probability table of each contributing factor was measured using a questionnaire. *Results.* The prior probability of fall events was 5.34% (53 cases per 1000 operational workers in 12 months). The posterior probability predicted that using fall protection devices and safe

working platforms will decrease more than half (58%) of fall occupational incidents. *Conclusion.* Bayesian network features including graphical representation, easy belief updating, performance testing and sensitivity analysis facilitate the process of predicting occupational incident probability including fall events. The proposed approach is a step toward quantitative risk analysis of occupational incidents.

- **Keywords:** fall incident, Bayesian network, incident prediction, oil industry

**Shitan Wang, Juyeon Park & Yunyi Wang. *Cross-cultural comparison of firefighters' perception of mobility and occupational injury risks associated with personal protective equipment.* Pages: 664-672.**

*Purpose.* The objective of this study was to compare the effects of personal protective equipment (PPE) on firefighters' perceptions of mobility and their experienced occupational injury risks between China and the USA. *Materials and methods.* An online survey was conducted and a total of 328 firefighters, including 203 Chinese firefighters and 125 US firefighters, participated in the survey. *Results.* Both Chinese and US firefighters ranked mobility restriction as the most dissatisfactory characteristic of the current PPE. US firefighters reported the upper body as the most restricted region and self-contained breathing apparatus (SCBA) as the most dissatisfactory item. Chinese firefighters ranked boots as the leading cause of dissatisfaction, but they did not indicate any particular discomfort region. Moreover, musculoskeletal disorders (MSDs) were the most prevalent occupational injury reported by both Chinese and US firefighters. Restricted mobility while wearing PPE was closely related to the risk of MSDs. *Conclusions.* The findings suggested that PPE design for US firefighters should consider a balance in the weight distribution of SCBA and the overall interface of turnout gear and equipment. For Chinese firefighters' PPE, flexibility of materials for boots should be emphasized to increase mobility and reduce the risks of MSDs.

- **Keywords:** firefighters, personal protective equipment, mobility, occupational injury, cross-cultural comparison

**Wen Cong Lim, Shazed Mohammad Tashrif, Yang Miang Goh & Soo Jin Adrian Koh. *Validation of the energy balance approach for design of vertical lifeline systems.* Pages: 673-685.**

To ensure that vertical lifeline systems (VLLSs) are well designed, calculation methods are required to estimate the extension of a personal energy absorber (PEA) ( $x_{PEA}$ ) and the total fall distance ( $h_{TFD}$ ). Thus, the authors conducted 28 tests to validate the accuracy of the energy balance approach for estimating  $x_{PEA}$  and  $h_{TFD}$  of VLLSs and propose suitable correction factors to improve the accuracy and safety of the estimated  $x_{PEA}$  and  $h_{TFD}$ . For 9 out of 19 tests with a PEA, the difference between the theoretical  $x_{PEA}$  and empirical  $x_{PEA}$  was 25% or higher, indicating that the energy balance approach is not accurate for estimation of  $x_{PEA}$ . In contrast, theoretical values of  $h_{TFD}$  are more accurate. Linear regression equations for estimating  $x_{PEA}$  ( $R^2 = 0.81$ ) and  $h_{TFD}$  ( $R^2 = 0.99$ ) were developed. The regression equations can be used to improve the accuracy and conservativeness of estimations of  $x_{PEA}$  and  $h_{TFD}$  during the design of VLLSs.

- **Keywords:** vertical lifeline, personal fall arrest system, fall from height, occupational safety, accidents, drop test, personal protective equipment, work at height

**Sylwia Sumińska, Kamila Nowak, Barbara Łukomska & Hanna B. Cygan. *Cognitive functions of shift workers: paramedics and firefighters: an electroencephalography study.* Pages: 686-697.**

*Introduction.* Working shifts has a negative impact on employee health and cognitive efficiency. The purpose of this study was to investigate the impact of shift work on cognitive functions – attention and working memory – using both behavioural and electrophysiological measures. *Methods.* The study was carried out on a group of 34 shift employees (18 paramedics, 16 firefighters) and on 17 day workers. Participants performed the attention network test and the *N*-back task with two conditions (1-back, 2-back) while the electroencephalography signal was recorded. *Results.* Observations included a higher amplitude of the P200 potential in paramedics (compared to the control group), a higher amplitude of the P300 potential after work than on a day off and the lowest increase in power in the  $\theta$  band after the night shift. In firefighters, lower  $\alpha$  desynchronization and lower synchronization in the  $\alpha/\beta$  band were observed after a 24-h shift. Paramedics and firefighters had longer reaction times (*N*-back task). *Conclusions.* The results suggest that paramedics experience problems with sustained attention. Paramedics process visual stimuli in a different way; after a night shift, performing the tasks required more engagement of cognitive resources. For firefighters, a decrease in visual attention functions and cognitive inhibition was observed.

- **Keywords:** shift work, paramedics, firefighters, cognitive functions, attention, working memory

**Paulina Kropidłowska, Emilia Irzmańska, Piotr Zgórniak & Paulina Byczkowska. *Evaluation of the mechanical strength and protective properties of polycarbonate toecaps subjected to repeated impacts simulating workplace conditions.* Pages: 698-707.**

The objective of this work was to examine the mechanical strength properties of polycarbonate toecaps designed for commercially available protective footwear, subjected to repeated impacts simulating workplace conditions. The effects of impacts on the toecaps were expressed as the height of toecap clearance, which has a direct bearing on the safe use of protective footwear. Changes in toecap geometry were evaluated using an originally developed methodology taking into consideration the requirements of Standard No. EN ISO 22568-2:2019. Additionally, external and internal sides of toecaps were scanned in three dimensions after each impact and reverse engineering was used to analyze deformations in toecap geometry by comparing the shape of the toecaps before and after impact. Three-dimensional scanning made it possible to measure the remaining safe distance for toes between the footwear sole and the impacted toecap surface, which is an indicator of the protective properties and safety of toecaps during use.

- **Keywords:** toecaps, footwear, impact testing, three-dimensional scanning, reverse engineering, occupational safety

**Sarah Anderson, Rwth Stuckey & Jodi Oakman. *Work-related musculoskeletal injuries in prosthetists and orthotists in Australia.* Pages: 708-713.**

*Objective.* This study aims to determine the prevalence of work-related musculoskeletal disorders in prosthetists/orthotists working in Australia. Secondary to this, the relationship between work-related hazards and work-related musculoskeletal disorders will be examined. *Methods.* In 2012, a self-report survey was conducted with the prosthetist/orthotist workforce in Australia ( $N=139$ , 56% response rate). Data on workplace physical and psychosocial hazards, job satisfaction, work-life balance and musculoskeletal discomfort were collected. Predictors of work-related musculoskeletal disorders were assessed using logistic regression analysis. *Results.* Prevalence of work-related musculoskeletal disorders was 80%. Gender ( $\beta = 1.31, p = 0.030$ ), total weekly hours ( $\beta = 0.9, p < 0.010$ ) and physical ( $\beta = 1.91, p < 0.010$ ) and psychosocial ( $\beta = 1.28, p < 0.010$ ) hazards were all associated with reporting of work-related

musculoskeletal disorders. Females reported higher levels of work-related musculoskeletal disorder discomfort than males in all body areas. *Conclusions.* Work-related musculoskeletal disorders prevalence is high in prosthetists/orthotists. This suggests that focus on workplace injury prevention is required. Targeted prevention requires systematic identification and then control of all relevant workplace hazards.

- **Keywords:** word, work-related musculoskeletal disorder, work injury, musculoskeletal injury, prosthetist, orthotist

**Ali Mohammad Saedi, Amran Ab Majid & Zaidi Isa. *Evaluation of safety climate differences among employees' demographic variables: a cross-sectional study in two different-sized manufacturing industries in Malaysia.* Pages: 714-727.**

*Introduction.* Demographic information is one of the key parameters that organizations utilize to modify their practices in order to respond to the existing risk within work environments. The present article aims to assess the level of safety climate factors as well as to evaluate the influence of personal factors on safety climate in two different-sized industries. *Methods.* A total of 216 employees in two large and three small and medium-sized chemical manufacturing industries responded to a questionnaire. Descriptive statistics were used to measure the safety climate level; a two-independent-sample Mann-Whitney *U* test and a Kruskal-Wallis test were run to compare the difference in safety climate scores among different demographic variables. *Results.* The lower level of safety climate in small and medium-sized industries revealed lower understanding and performance of management and non-management with regard to safety climate compared to the large industries. Additionally, significant mean differences on some safety climate factors among demographic variables were detected in both sizes of industries, emphasizing the important role of the employees' demographic variables on the plants' safety climate. *Conclusion.* Improving organization-level and group-level safety climates is recommended to improve employees' level of safety climate and control their personal factors.

- **Keywords:** demographic information, employees' perception, manufacturing industry, safety climate

**Nastja Podrekar, Žiga Kozinc & Nejc Šarabon. *Effects of cycle and treadmill desks on energy expenditure and cardiometabolic parameters in sedentary workers: review and meta-analysis.* Pages: 728-736.**

*Purpose.* The aim of this article was to evaluate the effects of cycle and treadmill desks on energy expenditure and cardiovascular and biochemical indicators in sedentary workers. *Materials and methods.* In February 2018, six databases were searched. Both parallel and crossover design studies evaluating workplace cycle and treadmill desks compared to a conventional seated condition were included. *Results.* Twenty-two studies met the inclusion criteria. Cycle and treadmill desks significantly increased energy expenditure (standard mean difference [SMD] = 3.84,  $p < 0.001$ ,  $I^2 = 95\%$ ) and the heart rate (SMD = 1.68,  $p < 0.001$ ,  $I^2 = 91\%$ ), and lowered blood glucose and insulin levels (SMD = -0.54,  $p < 0.001$ ,  $I^2 = 0\%$  and SMD = -3.13,  $p < 0.001$ ,  $I^2 = 76\%$ , respectively). The interventions had no effect on blood pressure and other biochemical indicators. *Conclusion.* Cycle and treadmill desks may positively influence energy expenditure in sedentary workers and could be effective for reducing negative effects of workplace-related sedentary behaviour. However, considerable heterogeneity is present in the measuring protocols for energy expenditure.

- **Keywords:** active work, station, bike desk, walking desk, workplace ergonomics, workplace intervention

**Ivana Špelić, Slavenka Petrak & Maja Mahnić Naglič. *The correction of clothing insulation and ergonomic design through 3D CAD reverse engineering.* Pages: 737-753.**

Three-dimensional (3D) scanning and computer-aided design (CAD) technology has been used in engineering and ergonomics practice for several years, due to their admissibility in producing accurate 3D object representation, scan data restoration and modification. Lately, application was extended for reconstructing and modelling 3D scan data of the human body, since this enables tracing the geometry information and precise measurement analysis. In this study, this technology was applied to analyse scanned models of a dressed human body. The changes in microclimatic air distribution and clothing area due to changing upper limb positions, simulating functional reaching movements for aircrew personnel, were calculated using 3D scanning and CAD technology. The results prove the posture representing the overall lateral limit of reach to be the best for the volume and area identification by means of 3D scanning. The study will further serve as a basis to modify clothing prototypes for improved thermal protection.

- **Keywords:** 3D CAD reverse engineering, 3D CAD volumetric and area analysis, clothing insulation modification, clothing prototypes for thermal protection

**Javier Llamazares, Sergio A. Useche, Luis Montoro & Francisco Alonso. *Commuting accidents of Spanish professional drivers: when occupational risk exceeds the workplace.* Pages: 754-762.**

*Background.* Work traffic accidents are an issue both in Spain and all over the world, and specific evidence on commuting accidents is scarce. Even though both industrial safety and welfare have been improved during the last decades, the commuting accidents rate is growing worldwide. *Purpose.* The aim of this study was to examine and describe the characteristics of commuting traffic crashes of Spanish professional drivers. *Materials and methods.* For this cross-sectional study, commuting accidents suffered by drivers during the last 12 years were analyzed. Crossed and heatmap-based analyses were performed in order to establish patterns and driver-based differences among commuting crashes. *Results.* Commuting crashes' features were found to be associated with demographic and job-related variables of professional drivers. Drivers' gender, time slots (peak/off-peak hours) and the specific hour of the event explained different trends in accident severity and characteristics. *Conclusions.* The results of this study suggest that commuting accidents involving professional drivers differ in demographic and situational issues from general and on-duty professional drivers' traffic crashes. Also, since in Spain commuting crashes are occupational accidents, more numerous and better actions should be taken in this regard, especially considering the association of professional drivers' accidents with fatigue and shift-working.

- **Keywords:** commuting accidents, professional drivers, driver features, working conditions, traffic crashes, traffic injuries

**Violeta Stefanović, Snežana Urošević, Željko Stević & Ivana Mladenović-Ranisavljević. *Multicriteria ranking of the influential factors of safety as criteria for development of the occupational safety and health climate.* Pages: 763-773.**

The research in this article aimed at determining the importance of occupational safety and health (OSH) factors at work as criteria for development of the OSH climate. Based on the views of 28 responsible persons of the OSH management system, the significance of the criteria was determined using the rough step-wise weight assessment ratio analysis method. The obtained results show that development of the OSH climate in

organizations primarily depends on the factors of the work environment and the commitment of the management to the OSH system. The results also point out that education of employees in the field of safety at work has a significant impact. A comparison of the obtained results was made in the sensitivity analysis using the full consistency method. The specific dimensions of the safety climate at work were determined and ranking of the OSH factors was performed.

- **Keywords:** factors, occupational safety and health, rough step-wise weight assessment ratio analysis, working conditions

**Migunthanna Kariyakaranage Janitha Madhavi & Gardiyas Hewawasam Mummullage Jimila Subashi De Silva. *Whole-body vibration exposure of roller compactor operators: characteristics and effect of waste rubber in damping the vibration.* Pages: 774-783.**

Whole-body vibration (WBV) exposure of 12 roller compactor operators were measured to investigate the characteristics of WBV transmitted to the roller compactor operators and to assess their level of exposure to WBV. All of the subjects were in the seated position and vibration transmission at the interface between the operator and seat was measured. Operators showed a dominant WBV transmission in the vertical direction. Eight-hour exposure and the vibration dose value were used to assess operators' exposure to WBV. In total, 75% of operators had high or moderate potential health risk defined in the health guidance caution zone specified in Standard No. ISO 2631-1:1997. A rubber mat produced with waste rubber sludge was used to investigate the effect of damping the vibration transmitted to the operator. The rubber mat damped the WBV transmission in all three directions: 18% in vertical, 5% in lateral and 2% in fore-and-aft directions.

- **Keywords:** whole-body vibration, roller compactors, Standard No. ISO 2631-1:1997, damping, waste rubber

**Silvia Ahmed Khattak. *Role of ergonomics in re-designing job design in call centres.* Pages: 784-793.**

*Purpose.* The ergonomics focus regarding job design is to address the issue of fitting the job to the worker. This means that other things such as space, matter, pedagogical parameters and the organizational environment need to be adjusted to the worker, to obtain optimal performance. Hence, it is important that jobs are designed in such a way that the environment of the worker becomes ergonomically better. *Methods.* Seventeen interviews were undertaken with employees from call centres of three major telecom companies in Islamabad. The interviews were semi-structured and NVivo version 10 was used for analysis. *Results.* The results indicated an influence of the following ergonomic factors on job design: (a) force, mental well-being and supervisor and peer support acted more on the complexity of the task; (b) inappropriate postures, mental well-being, characteristics of work, supervisor and peer support and the work environment acted on the skill and efforts required; (c) repetitiveness, workstation design, mental well-being, supervisor and peer support, work environment and characteristics of work acted more on the degree of worker's control. *Conclusion.* The issues related to these factors should be addressed to improve job design in the workplace.

- **Keywords:** job design, physical ergonomics, cognitive ergonomics, organizational ergonomics, call centres

**Shilpi K. Prasad, Siddhartha Singh, Ananya Bose, Bimlesh Prasad, Oly Banerjee, Ankita Bhattacharjee, Bithin K. Maji, Amalendu Samanta & Sandip Mukherjee. *Association between duration of coal dust exposure***

**and respiratory impairment in coal miners of West Bengal, India. Pages: 794-804.**

*Purpose.* The prevalence and severity of respiratory disorders are very high among coal miners as continuous exposure of workers in such an environment leads to accumulation of dust in the lungs. This study was designed to assess the prevalence of lung function impairment and to determine whether there is any correlation between dust exposure duration and lung function indices. *Materials.* Two hundred and thirty underground coal dust-exposed workers and 130 age-matched non-exposed workers were recruited from an underground mine in West Bengal, India. A spirometry test was performed for lung function and also basic information on personnel's dust exposure, smoking and respiratory morbidity was collected. Student's *t* test, Pearson's correlation coefficient (*r*), uncorrected Pearson's  $\chi^2$  test and Fischer's exact test were performed for statistical analysis. *Results.* Lung function indices were significantly ( $p < 0.050$ ) impaired between the exposed (43.91%) and non-exposed (23.85%) groups. In addition, highly significant decrements in the pulmonary volumes of exposed subjects were also noted. Furthermore, a high negative correlation was observed between spirometric results and exposure time in the exposed group compared with the non-exposed group. *Conclusion.* This study suggested a positive relationship between exposure time and lung function deterioration.

- **Keywords:** coal miners, pulmonary function, respiratory morbidity, dust exposure, work experience

**Burak Efe & Mustafa Kurt. A novel approach recommendation for hazard analysis. Pages: 805-816.**

Hazard evaluation generally defines the ranking of hazards in the work environment and ignores the interaction of hazards. This article aims to overcome this drawback using a fuzzy cognitive map (FCM) approach to analyze the interaction of hazards related to sheathing tasks in a construction firm. The FCM approach can be insufficient for hazard evaluation over the long term due to certain budget and time restrictions allocated by the firm. When the firm allocates more time and budget for a process, the firm must limit the allocated time and budget for the other processes. This article aims to overcome this problem so linear programming is used to optimize the goal and resources of the firm. The article contributes to hazard evaluation of sheathing tasks in a construction firm considering the interaction of the hazards and the capacity of the firm.

- **Keywords:** hazard analysis, fuzzy cognitive map, linear programming, occupational health and safety, decision support system

**Salman Majeed, Mati Ur Rahman, Hammad Majeed, Sami Ur Rahman, Asif Hayat & Sandra D. Smith. Chemical mismanagement and skin burns among hospitalized and outpatient department patients. Pages: 817-830.**

*Purpose.* This article attempts to elucidate the nature of chemicals causing major and minor skin burns, and their associated characterization across different industries, using Fujian provincial hospitals' admission and outpatient department records. *Materials and methods.* Data were collected from the provincial hospitals of Fujian through a questionnaire, sent via email, from June 1, 2017 to November 30, 2017. The collected responses were statistically analyzed using SPSS version 19 through the interquartile range, median, Mann-Whitney *U* test and Fisher's exact test with two-tailed significance. *Results and conclusions.* The results of 306 collected responses reveal that the majority of skin burn cases are due to a lack of technical education and professional training among workers handling chemicals. This study suggests that management's

effective supervision and governmental regulations may help to prevent chemical skin burns at work, and can further be controlled by hiring professional workers alongside providing training to them in chemical handling as well as using protective equipment and developing appropriate management policies to improve victims' well-being and quality of life. Findings will help workers, doctors, hospitals, industries, government and other stakeholders to understand and control chemical hazards on site to minimize the risks of chemical skin burn incidents.

- **Keywords:** chemical burns, skin burns, burn prevention, occupational health and safety, management, well-being, quality of life

**Mohammad Javad Jafari, Reza Khosrowabadi, Soheila Khodakarim, Fariba Khodaghali & Farough Mohammadian. *The effects of combined exposure to noise and heat on human salivary cortisol and blood pressure.* Pages: 831-839.**

*Purpose.* Noise and heat are the most important physical hazardous agents that can affect physiological parameters. This study investigated the independent and combined effects of noise and heat exposure on human saliva cortisol and blood pressure. *Methods.* In this experimental study, 72 students were exposed to noise (at sound pressure levels of 45, 75, 85 and 95 dB(A)) and heat (at wet bulb globe temperatures [WBGTs] of 22, 29 and 34 °C) for 30 min. Samples of saliva and blood pressure were taken before and after each independent and combined exposure. *Results.* The results revealed that the average saliva cortisol and blood pressure in male and female subjects increased significantly after independent exposure to noise at 95 dB(A) and a WBGT of 34 °C. The combined exposure to noise and heat increased saliva cortisol and blood pressure, which was statistically significant for three combinations of 95 dB(A) at 34 °C, 95 dB(A) at 29 °C and 85 dB(A) at 34 °C. *Conclusions.* Combined exposure to noise and heat could affect saliva cortisol and blood pressure in both male and female groups. Further studies are recommended to capture other combinations of physical hazardous agents, especially in the field.

- **Keywords:** noise, heat stress, salivary cortisol, blood pressure, combined exposure

**M<sup>a</sup> Jesús López-González, Silvia González & Eva González-Menéndez. *Prevalence of musculoskeletal problems in laboratory technicians.* Pages: 840-851.**

*Purpose.* The aim of this work was to analyze the prevalence of work-related musculoskeletal symptoms in laboratory technicians and their relation to personal and organizational factors, as well as the lack of specific training on work-related risks. *Methods.* A standardized Nordic questionnaire made for the Spanish population and a survey of sociodemographic variables and organizational aspects were applied to a sample of 460 Spanish laboratory technicians. The statistical analysis was done through R version 3.4.3. *Results.* Of the sample studied, 84.5% presented some musculoskeletal discomfort, with a higher percentage in women. The probability of having discomfort was eight times higher for those older than 46 years and the most affected part of the body was the neck. The variables that were associated more significantly with the probability to suffer discomfort in the most affected parts of the body (neck, right shoulder and right wrist) were gender, education level, prevention knowledge and seniority. *Conclusions.* It is necessary to implement plans to train in specific risks according to the activities done by these professionals.

- **Keywords:** laboratory technicians, musculoskeletal disorders, standardized Nordic musculoskeletal questionnaire, prevalence, ergonomics

**Mahnaz Shakerian, Alireza Choobineh, Mehdi Jahangiri, Jafar Hasanzadeh & Mohammad Nami. *Is 'invisible gorilla' self-reportedly measurable? Development and validation of a new questionnaire for measuring cognitive unsafe behaviors of front-line industrial workers.* Pages: 852-866.**

The most complicated problem in detecting workplace hazards is the dynamic condition of industrial settings and the unpredictability of workers' behavior. A newly developed method focusing on cognitive differences between individuals is required to evaluate unsafe behaviors of workers. This study aimed at development and validation of a new questionnaire for measuring cognitive unsafe behaviors of front-line industrial workers. A new questionnaire with 61 items was developed and the main measurement characteristics (validity and reliability) were analyzed. Content validity analysis showed that 61 items had an excellent content validity index ( $<0.78$ ) and content validity ratio ( $>0.42$ ). Good internal consistency (Cronbach's  $\alpha = 0.95$ ) and stability (intra-class correlation coefficient =  $0.98$ ) were found for the new instrument. The result of confirmatory factor analysis indicated that the selected model was satisfactory. The new instrument appears to be a valid and reliable tool to assess cognitive unsafe behaviors of front-line industrial workers.

- **Keywords:** cognitive factors, unsafe behavior, human factors, front-line workers

**Masoud Neghab, Ali Ebrahimi & Esmaeel Soleimani. *Respiratory symptoms and lung functional impairments associated with occupational exposure to poultry house pollutants.* Pages: 867-873."**

This study aimed to assess respiratory symptoms and the pulmonary function test (PFT) in a group of poultry workers. The prevalence of respiratory symptoms was determined. Airborne concentrations of total and respirable dusts exceeded the threshold limit values. Gram-positive cocci and Cladosporium were the dominant genera of bacteria and fungi, respectively. The prevalence of respiratory symptoms was significantly higher in the exposed subjects. Mean baseline values of forced expiratory volume (FEV<sub>1</sub>), FEV<sub>1</sub> to forced vital capacity (FVC) ratio (FEV<sub>1</sub>/FVC) and peak expiratory flow (PEF) were significantly lower in the exposed group. Significant cross-shift decrements were noted in vital capacity (VC), FVC, FEV<sub>1</sub>, PEF and FEV<sub>1</sub>/FVC of the exposed subjects. A dominant pattern of lung function abnormality was found to be obstructive. Exposure to poultry pollutants may result in a significant increase in the prevalence of respiratory symptoms as well as both acute reversible and chronic irreversible decrements in the PFT.

- **Keywords:** poultry workers, bioaerosols, occupational exposure, pulmonary function, respiratory symptoms

**Bu Zhong, Xiaohua Wang & Fan Yang. *More than an apple: better lunch enhances bus drivers' work performance and well-being.* Pages: 874-883.**

This study aims to seek affordable solutions to help bus drivers reach their health goals and improve work performance. Guided by Herzberg's motivation theory and self-determination theory, the study investigates ways of reducing the psychological risks bus drivers face by conducting an experiment among them in Shenzhen, China. During the experiment, a serving of fresh fruit (e.g., an apple or a banana) was added to their lunch for 3 weeks. The enhanced lunch helped improve work performance and well-being. Specifically, eating an extra apple or banana was found to reduce depression, and improve self-efficacy and traffic safety. The results indicate that bus drivers could be motivated to work harder as a response to small attention paid to them. This research contributes to a better understanding of food impact on work performance and well-

being. It also makes a theoretical contribution to the debate on how hygiene factors may alter job performance.

- **Keywords:** bus driver, public safety, traffic safety, work performance, depression, well-being: self-efficacyworking condition

**Seung Tae Yang, Byung Yong Jeong & Myoung Hwan Park. *Analysis of occupational injuries and the risk management of automobile parts manufacturing work.* Pages: 884-895.**

*Background.* Unexpected occupational injuries frequently occur in the automobile parts manufacturing industry. This study investigates the characteristics of occupational injuries and risk management for the workers in the industry. *Methods.* From the national industrial accident compensation data in Korea, 1530 occupational injuries were analyzed by nature and source of injury and illness according to work process. Also, this study derived the risk management level for prioritizing preventative measures. *Results.* The most critical injuries were 'ACC (amputation or caught in or crushed or compressed)' caused by 'misoperation or malfunction of machine and equipment' in the 'fabrication' and the 'maintenance' processes. Possible incidents predicted as a 'high' level of risk management were 'struck' (struck by or against objects) caused by 'misoperation or malfunction of machine and equipment' and ACC during 'installation of jig and mold' in the 'fabrication' process. ACC during 'maintenance' of 'operating jig and mold' is also classified 'high'. *Discussion and conclusion.* Using the findings of this study, effective preventative measures to reduce occupational injuries according to the risk level are suggested and discussed for automobile parts manufacturing works.

- **Keywords:** automobile parts manufacturing, work process, risk assessment, occupational injury, risk management level

**Eva Westergren, Mette Spliid Ludvigsen & Magnus Lindberg. *Prevalence of musculoskeletal complaints among haemodialysis nurses: a comparison between Danish and Swedish samples.* Pages: 896-901.**

*Objective.* The repetitiveness of priming and dismantling disposables for haemodialysis treatments might be an important contributor to musculoskeletal complaints. The objective was therefore to compare the prevalence of musculoskeletal complaints among haemodialysis nurses in Denmark and Sweden. *Methods.* For this cross-sectional study, nurses were recruited from haemodialysis centres in Denmark ( $n = 194$ ) and Sweden ( $n = 351$ ). Prevalence of musculoskeletal complaints was evaluated using the Nordic musculoskeletal questionnaire. *Results.* The percentage of nurses reporting musculoskeletal complaints from at least one part of their body was 90.2% in the Danish sample and 88.9% in the Swedish sample. The anatomical locations with the most complaints were the neck, lower back and hands. Except for the proportion of complaints concerning the neck, there were no differences between the countries. Absenteeism from work was mostly due to complaints regarding the hands. *Conclusion.* The prevalence of musculoskeletal complaints seems to be higher among haemodialysis nurses than among nurses in general. Because complaints concerning the hands are common, and also related to absenteeism from work, it is of particular importance that manufacturers of dialysis equipment and nurse managers acknowledge these occupational health and safety hazards in their efforts to create a good work environment.

- **Keywords:** work-related musculoskeletal disorders, haemodialysis, nurse, Nordic musculoskeletal questionnaire, prevalence, ergonomics

**Mark D. Threeton, Kibum Kwon, Joey A. Fleck, R. Brian Ketchem & Leila Farzam. *An investigation of instructional practices which promote occupational safety and health.* Pages: 902-910.**

In order to promote insight into providing secure teaching and learning environments within schools, this study sought to: (a) explore instructional practices utilized by educators to promote occupational safety and health (OSH) and hearing protection within career and technical education programs; and (b) identify what barriers may exist which prevent instructors from teaching OSH and hearing protection. Utilizing a focus group methodology, this research examined automotive and diesel technology instructors within an eastern US state. Upon analysis, safety appears to be a priority for participants in this study. However, the results suggested areas in need of improvement. The conclusions would be useful to OSH professionals, workforce development educators and leaders interested in application of enhanced OSH practices.

- **Keywords:** occupational safety and health, hearing protection, workforce development, education and training, career and technical education

**Andrzej Jan Olak, Irena Hejduk, Waldemar Karwowski, Przemyslaw Tomczyk, Jan Fazlagić, Paweł Gac, Hubert Hejduk, Sylvia Sobolewska, Erman Çakit & Omar A. Alrehaili. *The relationships between the use of smart mobile technology, safety knowledge and propensity to follow safe practices at work.* Pages: 911-920.**

The main objective of this study was to investigate the relationships between the use of smart technology (mobile phones) and the implicit (tacit) and explicit safety knowledge of employees and their propensity to follow safe practices at work. A survey was performed with seven constructs: (a) use of mobile technology; (b) tacit safety knowledge; (c) explicit safety knowledge of unsafe behaviors; (d) attitudes toward safety: emotional aspects; (e) safety culture: behavioral and psychological aspects of work; (f) safety culture: aspects of work; (g) safety culture: regulations at work. Workers from three manufacturing companies located in southeastern Poland completed a paper-based survey. The results revealed that using mobile technology positively influenced the explicit safety knowledge of employees, as well as their assessed safety culture, in terms of behavioral aspects and their attitudes toward safety expressed through the psychological aspects of safety culture.

- **Keywords:** mobile technology, use of smartphones, safety, knowledge management, safe work practices, structural equation modeling

**Serap Ulusam Seçkiner & Hüseyin Ünal. *Comparing the alternatives for the most favourable personal protective equipment.* Pages: 921-927.**

Evaluation of personal protective equipment is a very demanding task in designing an effective workplace safety programme. There is variable equipment to prevent job accidents, to protect workers' health and safety and to minimize the damage of any possible accident. Comparing the alternatives for the most favourable equipment, e.g. possible high noise levels, is one of the most difficult issues to deal with. In this study, the analytic hierarchy process method allows selection of personal protective equipment analytically, which is used to decide on efficient personal protection equipment when choosing protective shoes, helmets, earmuffs and dust masks.

- **Keywords:** analytic hierarchy process, occupational health, work safety, personal protective equipment

**Omran Ahmadi, Seyyed Bagher Mortazavi & Hasan Asilian Mahabadi. Application and modification of the Tripod Beta method for analyzing the causes of oil and gas industry accidents. Pages: 928-937.**

*Background.* Understanding the causes of accidents plays a major role in learning from accidents and developing accident prevention and control strategies. *Objective.* This study aimed at application and modification of the Tripod Beta method for analyzing accident causes in the oil and gas industries. *Materials and methods.* A total of 68 accidents occurring in the oil and gas industries during 2005–2016 were analyzed. For this purpose, we used the Tripod Beta method and modified it using Reason's Swiss cheese model and analysis accident results. *Results.* The main causes that have been ignored in the Tripod Beta method were supervision factors involved in 66% of the accidents (underlying causes) and unsafe conditions that contributed to 55% of accidents (immediate causes). The former was incorporated as a sublayer of the underlying cause and the latter as a sublayer of immediate cause to the modified Tripod Beta method. *Conclusions.* The results of the present study added to the knowledge on the causes of accidents. These results can help increase the capabilities of the Tripod Beta method for analyzing accident causes, such as supervision factors and unsafe conditions, which have been ignored in analyses performed using the Tripod Beta method.

- **Keywords:** accident analysis, root cause, underlying cause, immediate cause

**Krzysztof Baszczyński. Effects of full body harness design on fall arrest performance. Pages: 938-945.**

The use of personal protective equipment, including a safety harness, is one of the basic methods of protection against falls from a height. The presented studies, using an anthropomorphic dummy, identified the effect on the human body of the dangerous phenomena accompanying safety harness performance during fall arrest. The displacement of the dummy in the safety harness, the mutual displacement of the adjustment buckles and the webbing of the harness, the tightening of the straps on the dummy and the impacts exerted on the head of the dummy by the harness elements were considered. The correlation between the design of the safety harness and the parameters and phenomena in question has been demonstrated. It has been shown that for the purposes of assessment of novel harness designs it is necessary to carry out studies utilizing an anthropomorphic dummy in addition to resistance tests.

- **Keywords:** personal protective equipment, full body harness, fall arrest, anthropomorphic dummy arrest distance

**Marzena Malińska & Joanna Bugajska. Assessment of the impact of lifestyle and psychosocial working conditions on older employees' work ability. Pages: 946-955.**

*Objective.* The purpose of this article was to assess the impact of selected elements of lifestyle, psychosocial working conditions and general mental health on older employees' ability to work. *Methods.* Employees ( $N = 1067$ ) aged 50–65 years ( $M 54.8$ ,  $SD 3.95$ ) responded to a questionnaire on demographics, lifestyle characteristics, general mental health (general health questionnaire), psychosocial job characteristics (job content questionnaire) and work ability (work ability index [WAI]). A logistic regression model was used to assess the impact of the selected factors on work ability. *Results.* Older employees were characterized by good (44.4%) and moderate (36.4%) work ability. The average WAI scores were significantly higher among employees who did not smoke, consumed the recommended daily intake of vegetables, drank enough water, ate breakfast every morning, cut down on sweets and were on a vegetarian diet. Good physical (no sick leave) and mental health, high level of job control, low job insecurity

and use of over-the-counter drugs were found to be the strongest predictors of WAI scores. *Conclusions.* The results of the research indicate that most of the determinants of work ability identified at work are impacted, thus giving the opportunity to conduct some occupational health and preventive programmes in the workplace.

- **Keywords:** work ability, work ability index, lifestyle, psychosocial working conditions, ageing employees