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Goris Nazari, Joy C. MacDermid, Kathryn E. Sinden & Tom J. Overend. Comparison of Canadian firefighters and healthy controls based on submaximal fitness testing and strength considering age and gender. Pages: 1-7.

Introduction. Few studies have addressed whether firefighters are fitter than the general population and possess sufficient levels of aerobic capacity and muscle strength to perform on-duty tasks in a safe and efficient manner, considering age and gender. We aimed to evaluate the fitness levels of Hamilton firefighters, and to determine the effects of age and gender. Methods. In total, 89 participants were recruited. The modified Canadian aerobic fitness test was used to determine participants' estimated maximal oxygen consumption (VO₂max) levels. For upper and lower body strength levels, a calibrated J-Tech hand-held dynamometer and a National Institute for Occupational Safety and Health (NIOSH) lifting device was used respectively. Results. Firefighters' mean (SD) VO₂max level was 40.30 ± 6.25 ml·kg⁻¹·min⁻¹. Age proved to have a statistically significant impact on VO₂max (p < 0.001). Gender displayed statistically significant effects on strength levels. Firefighters' age was the only statistically significant independent variable, and accounted for 61.00% of the variance in firefighters' aerobic capacity levels. Conclusions. Firefighters possessed somewhat similar aerobic capacities but much higher levels of body strength when compared with the general population. With age, firefighters' aerobic capacities decreased; however, their upper and lower body strength levels remained the same.

- **Keywords:** firefighters, aerobic capacity, gender, age, physical fitness

Khamisah Awang Lukman, Mohammad Saffree Jeffree & Krishna Gopal Rampal. Lower back pain and its association with whole-body vibration and manual materials handling among commercial drivers in Sabah. Pages: 8-16.

A cross-sectional study was undertaken to determine the prevalence of lower back pain (LBP) and its association with whole-body vibration (WBV) and manual materials handling (MMH). We studied 110 commercial vehicle drivers using a self-administered questionnaire and the VI-400Pro human vibration monitor. Prevalence of LBP was 66.4%. The percentage of drivers who had frequent manual handling of heavy loads was 45.5%

and those who handled heavy loads in awkward postures accounted for 86.4%. Daily vibration A(8) averaged on the z axis was 0.25 (0.06) m·s⁻² and at vector sum was 0.29 (0.07) m·s⁻². Daily vibration exposures on the z axis, frequent manual handling of heavy loads and awkward posture during MMH were significantly associated with LBP. Drivers who are exposed to WBV and frequently handle heavy loads manually and with awkward postures probably have more LBP than drivers who are exposed to only one of these risk factors.

- **Keywords:** whole-body vibration, manual materials handling, lower back pain, commercial vehicle drivers

Achim Elfering, Sonja Cronenberg, Simone Grebner, Oezguer Tamcan & Urs Müller. *Measuring limitations in activities of daily living: a population-based validation of a short questionnaire.* Pages: 17-26.

Purpose. A newly developed questionnaire assessing limitations in activity of daily living (LADL-Q) that should improve assessment of LADL is tested in a large population-based validation study. Methods. This survey was paper-based. Overall, 16,634 individuals who were representative of the working population in the German-speaking part of Switzerland participated in the study. Item analysis was used the final version of the LADL-Q to four items per subscale that correspond to potential problems in three body regions (back and neck, upper extremities, lower extremities). Analysis included tests for reliability, internal consistency, dimensionality and convergent validity. Results. Test-retest reliability coefficients after 2 weeks ranged from 0.82 to 0.99 (Mdn = 0.87), with no item having a coefficient below 0.60. The median item-total coefficients ranged between moderate and good. Correlation coefficients between LADL-Q subscales and three validated clinical instruments (Western Ontario and McMaster Universities osteoarthritis index, shoulder pain disability index, Oswestry) ranged from 0.63 to 0.81. In structural equation modeling the three subscales were significantly related with two important outcomes in occupational rehabilitation: self-reported general health and daily task performance. Conclusion. The new LADL-Q is a brief, reliable and valid tool for assessment of LADL in studies on musculoskeletal health.

- **Keywords:** short questionnaire, occupational rehabilitation, locomotor system, musculoskeletal pain

Nobuo Yasuda & Brent C. Ruby. *Assessment of urinary protein composition in response to consecutive days of wildland firefighting.* Pages: 27-34.

The purpose of this study was to examine the pattern of urinary protein excretion induced by 3 consecutive days of wildland firefighting. Eighteen male active-duty military personnel served as the participants. All testing on the 3 consecutive days was conducted at a Northwestern USA fire camp. All participants consumed military-based foods containing 2620–2864 kcal/day. The work activity was evaluated with an accelerometer in association with body weight and hydration markers over the experimental period. Urinary samples were collected pre and post workshift on days 1 and 3 to assess glomerular and tubular protein excretion (total protein, albumin, β 2-microglobulin, N-acetyl- β -d-glucosaminidase and creatinine). The urinary levels of glomerular and tubular protein were not significantly different. The main findings of the present study indicate that similar alterations of urinary protein composition can be observed over consecutive days of wildland firefighting, which appears to be dependent on intensity rather than total work output.

- **Keywords:** energy balance, heat exposure, hydration, labor work, renal function, wildland firefighting

Yuta Endo, Atsushi Ohsawa & Mizuki Yamaguma. *Electrostatic hazards of charging of bedclothes and ignition in medical facilities*. Pages: 35-39".

We investigated the charge generated on bedclothes (cotton and polyester) during bedding exchange with different humidities and the ignitability of an alcohol-based hand sanitizer (72.3 mass% ethanol) due to static spark with different temperatures to identify the hazards of electrostatic shocks and ignitions occurring previously in medical facilities. The results indicated that charging of the polyester bedclothes may induce a human body potential of over about 10 kV, resulting in shocks even at a relative humidity of 50%, and a human body potential of higher than about 8 kV can cause a risk for the ignition of the hand sanitizer. The grounding of human bodies via footwear and flooring, therefore, is essential to avoid such hazards (or to reduce such risks).

- **Keywords:** static electricity, medical facility, hand sanitizer, ignition, electrostatic shock

Selim Baradan, Seyyit Umit Dikmen & Ozge Akboga Kale. *Impact of human development on safety consciousness in construction*. Pages: 40-50.

The International Labour Organization (ILO) reports that the risk of fatal occupational injuries in developing countries is almost twice as high as in developed countries, indicating a potential relationship between the fatality rates and the development level. The human development index (HDI), based on life expectancy, knowledge level and purchasing power parity, endorsed by the United Nations Development Programme, is a widely accepted measure of the development level. This study investigates the relationship between the HDI and the fatality rates reported by the ILO. A 23-country data set is used to demonstrate the general trend of the relationship followed by country-specific analyses for Australia, Spain, Hungary and Turkey. The study conducted is limited to fatal occupational injuries in construction, where the accidents are notoriously high. The results demonstrate a statistically significant inverse relationship between the fatality rates and the HDI.

- **Keywords:** construction, occupational health and safety, Human Development Index, fatality rates

Rohit Sharma, Kushal Kamboj & Jyoti Bhardwaj. *Gender response and safe carrying load limit for sugar industry workers*. Pages: 51-60.

This study investigates the safe carrying load limit in relation to gender of workers in the sugar industry. A total of 632 workers (male and female) were interviewed following a physiological and psycho-physiological methodology. All of these workers were in the age groups of 21–30, 31–40 and ≥ 41 years. In this study, for the physiological methodology, both field and laboratory data were collected, which included heart rate, heart rate variability, energy expenditure and maximum rate of oxygen consumption. Information regarding hemoglobin content, weight, age, lean body weight, etc., was recorded to know the physical health of the workers. In the psycho-physiological evaluation, load-carrying limits were determined by the psychophysical rating of the load by workers from the selected age groups. By considering the physiological stresses and psycho-physiological evaluation, the safe carrying load limit was determined in head and back mode for male and female workers as per their age groups.

- **Keywords:** physiological, psycho-physiological, heart rate, heart rate variability, walking speed, maximum rate of oxygen consumption, safe carrying load

Mohammad Javad Jafari, Abdullah Barkhordari, Davood Eskandari & Yadollah Mehrabi. *Relationships between certain individual characteristics and occupational accidents*. Pages: 61-65.

Background. Work accidents and injuries are an occupational health and safety problem. Methods. This cross-sectional study was conducted for 404 frontline workers who were randomly selected from the Arya Sasol Petrochemical Company in Bushehr, Iran, during 2016. A statistical analysis was performed using the χ^2 test and the logistic regression model with SPSS version 18. Results. The overall occupational accident rate among the participants was found to be 9.2%. Statistically significant differences were observed for body mass index, education, job experience, smoking habit, consumption of sedative pills and presence of sleep disorders. Three factors had significant adjusted odds ratios (ORs): body mass index (OR 2.41, 95% confidence interval [CI] [1.16, 5.04]), education (OR 0.25, 95% CI [0.07, 0.85]) and job experience (OR 0.29, 95% CI [0.15, 0.57]). Conclusions. Preventive programs should be implemented for industrial workers, especially young workers, workers who smoke, overweight workers and workers with psychosomatic disease.

- **Keywords:** occupational accidents, individual characteristics, smoking habit, psychotropic drug consumption

Alberto Martinetti, Maria Mikela Chatzimichailidou, Luisa Maida & Leo van Dongen. *Safety I-II, resilience and antifragility engineering: a debate explained through an accident occurring on a mobile elevating work platform*. Pages: 66-75.

Occupational health and safety (OHS) represents an important field of exploration for the research community: in spite of the growth of technological innovations, the increasing complexity of systems involves critical issues in terms of degradation of the safety levels. In such a situation, new safety management approaches are now mandatory in order to face the safety implications of the current technological evolutions. Along these lines, performing risk-based analysis alone seems not to be enough anymore. The evaluation of robustness, antifragility and resilience of a socio-technical system is now indispensable in order to face unforeseen events. This article will briefly introduce the topics of Safety I and Safety II, resilience engineering and antifragility engineering, explaining correlations, overlapping aspects and synergies. Secondly, the article will discuss the applications of those paradigms to a real accident, highlighting how they can challenge, stimulate and inspire research for improving OHS conditions.

- **Keywords:** Safety I, Safety II, resilience engineering, antifragility engineering, mobile elevating work platform

Magdalena Woynarowska-Soldan, Mariusz Panczyk, Lucyna Iwanow, Aleksander Zarzeka & Joanna Gotlib. *Validation of the positive health behaviours scale: a nationwide survey of nurses in Poland*. Pages: 76-85.

Purpose. The aim was to adjust the positive health behaviours scale (PHBS) to make it suitable for use by nurses, and to validate the new version of the tool. Methods. A previously formulated PHBS was modified. The scale comprises 29 statements describing certain positive health behaviours in four subscales: nutrition, physical activity, relaxation and behaviours related to mental health, and preventive behaviours. The scale was enriched with items on avoiding risky behaviours and a question regarding respondents' own assessment of their care for health. Analyses were conducted of reliability, construct validity, criterion validity and dimensionality of subscales. The questionnaire was completed by 1017 nurses. Results. Cronbach's α reached 0.844 for the entire scale and 0.623–0.761 for specific subscales. Empirical data did not confirm theoretical

assumptions regarding the existence of a four-element structure of the PHBS. The scale's diagnostic criteria were validated on the basis of positive results of correlation and trend analysis. Only one of the subscales proved homogeneous and could be considered unidimensional. Conclusions. The results confirmed the high internal consistency of the scale and its subscales. The factor structure of the PHBS was equivocal. The PHBS could be used in workplace-based health promotion programmes designed for nurses.

- **Keywords:** nurses, health behaviours, validation, positive health behaviours scale

Josiane Sotrato Gonçalves, Cristiane Shinohara Moriguchi, Karina Satiko Takekawa & Tatiana de Oliveira Sato. *Effects of work surface and task difficulty on neck-shoulder posture and trapezius activity during a simulated mouse task.* Pages: 86-90.

Objectives. The purpose of this study is to evaluate the influence of the work surface and task difficulty on the head, upper back and upper arm postures and activity of the descending trapezius during a simulated mouse task. **Methods.** Healthy female university students (N = 15) were evaluated. The work surface was positioned at elbow height (EH) and above elbow height (AEH) and the task difficulty was set at low (LD) and high (HD) levels. The postures were recorded by inclinometers. Trapezius activity was normalized by the maximum voluntary isometric contraction (MVIC). **Results.** Significantly higher head flexion was found at EH compared to the AEH condition, with an average difference of 2°–5° at the same difficulty level. The HD task significantly increased head (3°–6°) and upper back flexion (6°–7°) at the same table height. For upper arm elevation and trapezius activation, the AEH condition presented higher upper arm elevation (about 6°–8°) and trapezius activity (0.8–1.4% of MVIC), regardless of the difficulty level of the task. **Conclusions.** Head posture was influenced by the table height and task difficulty; the upper back posture by high difficulty; and upper arm posture and trapezius activity were only influenced by table height.

- **Keywords:** work-related musculoskeletal disorders, occupational biomechanics, inclinometry, psychosocial factors

Joon-Sig Jung, Jae Won Lee, Rajitha Kawshalya Mailan Arachchige Don, Duck Shin Park & Seung Cheol Hong. *Characteristics and potential human health hazards of charged aerosols generated by high-voltage power lines.* Pages: 91-98.

We investigated the characteristics of charged aerosols produced by high-voltage power lines (HVPLs) to explore the effects on respiratory disease incidence among those who handle HVPLs. Charged aerosol currents and charged aerosol concentrations were measured over 24 h at 12 sites. Aerosol current effective levels were 2.7 times higher compared to exposed and control sites. This pattern of relative enhancement at exposed sites was seen consistently in all measurements and the difference was 1.7 higher at exposed sites. Correlation analysis among all important variables revealed strong positive correlations between currents and concentration, currents and magnetic field, humidity and concentration, and humidity and particles of 10 µm or less (PM10), while negative correlations were observed between charged aerosol concentrations and wind velocity and between wind velocity and humidity. Estimated production of charged aerosols from HVPLs found that people who work with HVPLs are highly likely to be exposed to charged aerosols.

- **Keywords:** charged aerosol, corona discharge, high voltage power line, ambient particle

Patrick Manu, Anush Poghosyan, Ibrahim Mark Mshelia, Samuel Tekena Iwo, Abdul-Majeed Mahamadu & Krzysztof Dziekonski. *Design for occupational safety and health of workers in construction in developing countries: a study of architects in Nigeria*. Pages: 99-109.

Purpose. Design for safety (DfS) of workers is amongst the prominent ways of tackling poor occupational safety and health performance in construction. However, in developing countries there is extremely limited research on DfS. This study thus makes an important contribution to the subject of DfS in developing countries by specifically examining the awareness and practice of DfS amongst architects within the construction sector of Nigeria. Materials and methods. A survey of architects, yielding 161 valid responses, was conducted. Results. While there is high awareness of the concept of DfS, the actual practice is low. Additionally, although there is high interest in DfS training, the engagement in DfS training is low. Significantly, awareness of DfS, training and education related to DfS, and membership of a design professional body have very limited bearing on the practice of DfS by architects. Conclusions. The findings are thus symptomatic of the prevalence of influential DfS implementation barriers within the construction sector. Industry stakeholders should seek to raise the profile of DfS practice within the sector. Furthermore, similar empirical studies in the construction sector of other developing countries would be useful in shedding light on the status of DfS in these countries.

- **Keywords:** construction, design for safety, prevention through design, developing country, survey

Wonkyoung Shin & Minyong Park. *Ergonomic interventions for prevention of work-related musculoskeletal disorders in a small manufacturing assembly line*. Pages: 110-122.

This study involves performing improvements in workstation specification using a three-dimensional human modeling tool and proposing well-balanced work scheduling (WBWS) to prevent work-related musculoskeletal disorders (WMSDs) in a small manufacturing plant. To analyze risk factors of WMSDs, various tasks at 10 different types of workstation were evaluated with detailed motion analysis using a customized checklist. Questionnaires were administered to 27 workers to evaluate symptoms related to WMSDs. Revised workstation specifications were suggested based on anthropometric characteristics of workers using before-after analyses as an engineering control. Additionally, WBWS was proposed as an administrative control to avoid continuous physical stress on specific body parts in repetitive tasks. A software tool for WBWS was developed for convenient and easy application. The results of the study may aid managers in applying ergonomic interventions with time and cost savings, and enhance worker satisfaction and motivation due to improvements in working conditions to prevent WMSDs.

- **Keywords:** work-related musculoskeletal disorders, ergonomic controls, well-balanced work scheduling, three-dimensional human modeling, assembly line

Hatice Esen, Tuğçen Hatipoğlu, Ahmet Cihan & Nilgün Fiğlali. *Expert system application for prioritizing preventive actions for shift work: shift expert*. Pages: 123-137.

Introduction. Shift patterns, work hours, work arrangements and worker motivations have increasingly become key factors for job performance. The main objective of this article is to design an expert system that identifies the negative effects of shift work and prioritizes mitigation efforts according to their importance in preventing these negative effects. The proposed expert system will be referred to as the shift expert. Methods. A

thorough literature review is conducted to determine the effects of shift work on workers. Our work indicates that shift work is linked to demographic variables, sleepiness and fatigue, health and well-being, and social and domestic conditions. These parameters constitute the sections of a questionnaire designed to focus on 26 important issues related to shift work. The shift expert is then constructed to provide prevention advice at the individual and organizational levels, and it prioritizes this advice using a fuzzy analytic hierarchy process model, which considers comparison matrices provided by users during the prioritization process. An empirical study of 61 workers working on three rotating shifts is performed. After administering the questionnaires, the collected data are analyzed statistically, and then the shift expert produces individual and organizational recommendations for these workers.

- **Keywords:** ergonomics, shift work, expert system, fuzzy analytic hierarchy process

Alexis Rydell & Ing-Marie Andersson. *Work environment investments: outcomes from three cases.* Pages: 138-147.

Work environment investments are important in order to create a healthy and safe workplace. This article presents findings from a seven-step interventions process aimed at examining and following-up work environment investments in small and medium-sized enterprises (SMEs), with a particular focus on air contaminants. Three different cases were analyzed and included in the study: (a) an educational center for welding; (b) a paint station in furniture manufacturing; (c) a joinery in furniture manufacturing. The results show that the work environment investments were highly appreciated by the employees and managers, but at the same time the investment could be optimized through markedly decreased exposure levels for the worker. Factors such as follow-ups of the investment, education and training in how to use the equipment, worker involvement in the process and leadership engagement are important in order to optimize work environment investments.

- **Keywords:** efficiency, follow-up, intervention, occupational safety and health, occupational hygiene

Rami L. Abbas, Mohamad T. Hour, Mohammad M. Rayyan, Hamada Ahmad Hamada & Ibtissam M. Saab. *Effect of unifocal versus multifocal lenses on cervical spine posture in patients with presbyopia.* Pages: 148-152.

Significance. There are many environmental considerations which may or may not lead to the development of faulty cervical mechanics. The design of near-vision lenses could contribute to the development of such cervical dysfunction and consequently neck pain. Decision-making regarding the proper type of lens prescription seems important for presbyopic individuals. Purpose. To investigate the effect of unifocal and multifocal lenses on cervical posture. Methods. Thirty subjects (18 females and 12 males) participated in the study with an age range from 40 to 64 years. Each subject wore consequently both unifocal and multifocal lenses randomly while reading. Lateral cervical spine X-ray films were taken for each subject during each lens wearing. X-ray films were analyzed with digital software (AutoCAD 2D version 22) to measure segmental angles of the cervical vertebrae (occiput/C1, C1/C2, C2/C3, C3/C4, C4/C5, C5/C6, C6/C7, C3/C7, C0/C3, and occiput/C7). Results. Higher significant extension angles were observed in the segments C0/C7, C1/C2, C5/C6, C6/C7 and C3/C7 ($p < 0.05$) during multifocal lens wearing, in contrast to higher flexion angles between C3/C4 and C4/C5 ($p < 0.05$) when wearing unifocal lenses. Conclusion. Multifocal lens spectacles produce increased extension in the cervical vertebrae angles when compared with the use of unifocal lenses.

- **Keywords:** unifocal lenses, multifocal lenses, cervical spine, cervical posture, presbyopia, ergonomics

Arto Reiman, Tuomo Räisänen, Seppo Väyrynen & Tommi Autio. *Strategic accident reduction in an energy company and its resulting financial benefits.* Pages: 153-160.

This study provides a case example of an energy company that prioritized occupational safety and health and accident reduction as long-term, strategic development targets. Furthermore, this study describes the monetary benefits of this strategic decision. Company-specific accident indicators and monetary costs and benefits are evaluated. During the observation period (2010–2016), strategic investments in occupational safety and health cost the company EUR 0.8 million. However, EUR 1.8 million were saved in the same period, resulting in a 2.20 cost–benefit ratio. The trend in cost savings is strongly positive. Annual accident costs were EUR 0.4 million lower in 2016 compared to costs in 2010. This study demonstrates that long-term, strategic commitment to occupational safety and health provides monetary value.

- **Keywords:** economic benefits, lost-time accident, non-work accident, occupational accident, occupational safety and health

Leena Korpinen & Rauno Pääkkönen. *Workers' exposure to electric fields during the task 'maintenance of an operating device of circuit breaker from a service platform' at 110-kV substations.* Pages: 161-164.

The objective of the study was to investigate occupational exposure to electric fields during the task 'maintenance of an operating device of circuit breaker from a service platform' at 110-kV substations. The aim was also to compare the results to Directive 2013/35/EU. At 16 substations, 255 electric field measurements were performed. The highest mean value of the electric fields was $9.6 \text{ kV}\cdot\text{m}^{-1}$. At 63% of substations the maximum values were over $10.0 \text{ kV}\cdot\text{m}^{-1}$, and at 31% of the substations the 75th percentiles were over $10.0 \text{ kV}\cdot\text{m}^{-1}$, which is the low action level (AL) according to Directive 2013/35/EU. All measured values were below the high AL ($20.0 \text{ kV}\cdot\text{m}^{-1}$). In the future, it is important to take into account that the measurements were only taken at Finnish 110-kV substations; therefore, it is not possible to generalize these results to other countries and different types of substations.

- **Keywords:** electric field, exposure, measurements, electrical workers, physical agents directive