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Anna Marszałek, Grażyna Bartkowiak, Anna Dąbrowska, Sylwia Krzemińska, Krzysztof Łężak, Krzysztof Makowski & Joanna Bugajska. *Mine rescuers' heat load during the expenditure of physical effort in a hot environment, using ventilated underwear and selected breathing apparatus*. Pages: 1-13.

Mine rescuers' heat load under the same physical effort load (25% of the maximal oxygen uptake), using three types of breathing apparatus, in newly developed heat-removing underwear and outerwear was assessed for typical work conditions of mine rescuers, under milder and harsher ambient conditions of 32 and 38 °C, respectively, both at relative humidity of 85% and air velocity of 1.0 m/s. Expending physical effort at the same load while using different kinds of breathing apparatus resulted in a similar heat load. Under both milder and harsher ambient conditions, heat storage and sweating intensity were greater than the average limit value recommended by hygienic standards, which indicates that the use of breathing apparatus significantly hinders heat exchange with the environment. The developed clothing for mine rescuers was highly rated, and was considered by most people to be better than that used currently.

- **Keywords:** mine rescuers, heat load, ventilated underwear, protective clothing, breathing apparatus

Carl Mikael Lind. *Pushing and pulling: an assessment tool for occupational health and safety practitioners*. Pages: 14-26.

A tool has been developed for supporting practitioners when assessing manual pushing and pulling operations based on an initiative by two global companies in the manufacturing industry. The aim of the tool is to support occupational health and safety practitioners in risk assessment and risk management of pushing and pulling operations in the manufacturing and logistics industries. The tool is based on a nine-multiplier equation that includes a wide range of factors affecting an operator's health risk and capacity in pushing and pulling. These multipliers are based on psychophysical, physiological and biomechanical studies in combination with judgments from an expert group consisting of senior researchers and ergonomists. In order to consider usability, more than 50 occupational health and safety practitioners (e.g., ergonomists, managers, safety representatives and production personnel) participated in the development of the

tool. An evaluation by 22 ergonomists supports that the push/pull tool is user friendly in general.

- **Keywords:** risk assessment, risk management, manual handling, manual materials handling, RAMP tool, lower back pain, musculoskeletal disorder, force exertions

Todd D. Smith. *An assessment of safety climate, job satisfaction and turnover intention relationships using a national sample of workers from the USA*. Pages: 27-34.

The association between safety climate, job satisfaction and turnover intention has not been thoroughly researched. This research is needed so that safety researchers and practitioners can begin to delineate the impact of safety on organizational and business outcomes. A path analysis was completed using data from a national sample of workers from the USA ($n = 1525$). The overall fit of the model was excellent and analyses determined that both training and resource adequacy positively affected safety climate and job satisfaction. Safety climate also positively influenced job satisfaction. Both safety climate and job satisfaction were negatively associated with respondents' turnover intention. In the study, the relationship between job satisfaction and turnover intention is reiterated in a sample of workers across many industries. This study is novel because it is one of the first studies to confirm that turnover intention is reduced with increased safety climate in a diverse sample of workers.

- **Keywords:** occupational safety, safety climate, training, job satisfaction, turnover intention

Heiner Baur, Simone Grebner, Angela Blasimann, Anja Hirschmüller, Eva Johanna Kubosch & Achim Elfering. *Work–family conflict and neck and back pain in surgical nurses*. Pages: 35-40.

Objective. Surgical nurses' work is physically and mentally demanding, possibly leading to work–family conflict (WFC). The current study tests WFC to be a risk factor for neck and lower back pain (LBP). Job influence and social support are tested as resources that could buffer the detrimental impact of WFC. *Methods*. Forty-eight surgical nurses from two university hospitals in Germany and Switzerland were recruited. WFC was assessed with the Work–Family Conflict Scale. Job influence and social support were assessed with the Copenhagen Psychosocial Questionnaire, and back pain was assessed with the North American Spine Society Instrument. *Results*. Multiple linear regression analyses confirmed WFC as a significant predictor of cervical pain ($\beta = 0.45$, $p < 0.001$) and LBP ($\beta = 0.33$, $p = 0.012$). Job influence and social support did not turn out to be significant predictors and were not found to buffer the impact of WFC in moderator analyses. *Conclusion*. WFC is likely to affect neck and back pain in surgery nurses. Work–life interventions may have the potential to reduce WFC in surgery nurses.

- **Keywords:** cervical pain, Copenhagen Psychosocial Questionnaire, lumbar pain, North American Spine Society Outcome Assessment Instrument, Work–Family Conflict Scale

Neda Mahdavi, Majid Motamedzade, Ali Ashraf Jamshidi, Ebrahim Darvishi, Abbas Moghimbeygi & Rashid Heidari Moghadam. *Upper trapezius fatigue in carpet weaving: the impact of a repetitive task cycle*. Pages: 41-51.

Introduction. Shoulder disorders are one of the most prevalent musculoskeletal disorders among carpet weavers. The most important cause of these disorders is muscle fatigue.

The aim of the present study is to investigate the effect of carpet weaving characteristics on upper trapezius (UTr) muscle fatigue during a task cycle. *Method*. In this cross-sectional study, 9 women and 3 men participated. During an 80-min cycle of carpet weaving, a times-series model was applied to assess electromyography amplitude and frequency changes. *Result*. According to the joint analysis of electromyogram spectrum and amplitude method, the participants experienced 0% force decrease, 0.9% recovery, 18% force increase and 72% fatigue in the left UTr. Furthermore, the rates of force decrease, recovery, force increase and fatigue in the right UTr were 18%, 18%, 18% and 45%, respectively. Fatigue in the right and the left UTr was reported to be the dominant state during one carpet weaving task cycle. *Conclusion*. Task cycle appears to have a significant impact on UTr fatigue in participants, and UTr fatigue can be considered a serious risk factor in shoulder musculoskeletal disorders. Hence, further studies should focus on better workstations and work–rest periods during various subtasks.

- **Keywords:** muscle fatigue, upper limb musculoskeletal disorders, surface electromyography, ergonomics, Iran

Lorenzo Avanzi, Lucia Savadori & Franco Fraccaroli. *Unraveling the organizational mechanism at the root of safety compliance in an Italian manufacturing firm*. Pages: 52-61.

Safety performance is recognized as the more proximal and effective precursor of safety outcomes. In particular, safety compliance significantly reduces workplace accidents and injuries. However, it is not entirely clear what role organizational factors play in determining workers' safety. The present study contributes to defining which organizational factors increase safety compliance by testing a mediational model in which supervisor support is related to safety climate, which in turn is related to organizational identification that finally is related to safety compliance. We tested our hypotheses in a sample of 186 production workers of an Italian manufacturing firm using a cross-sectional design. Findings confirm our hypotheses. Management should consider these organizational factors in order to implement primary prevention practices against work accidents.

- **Keywords:** organizational identification, supervisor support, safety climate, safety compliance

Maysa Venturoso Gongora Buckeridge Serra, Paula Rezende Camargo, José Eduardo Zaia, Maria Georgina Marques Tonello & Paulo Roberto Veiga Quemelo. *Effects of physical exercise on musculoskeletal disorders, stress and quality of life in workers*. Pages: 62-67.

Background. The effect of physical exercise in the workplace (PEW) on health promotion of workers is contradictory. *Objective*. To evaluate the effects of the PEW in musculoskeletal disorders (MSDs), perception of stress and quality of life in workers. *Methods*. The participants were divided into two groups: control group ($n = 46$) including non-participant workers of the PEW program, and PEW group ($n = 50$) including workers who regularly participate in the exercise program. All workers answered the Nordic general questionnaire, the perceived stress scale and the quality-of-life questionnaire. *Results*. The PEW group reported a lower prevalence of MSDs for the trunk in the last 7 days and 12 months ($p = 0.021$ and $p = 0.001$, respectively), and for the upper limbs in the last 12 months ($p = 0.001$) compared with the control group. The results for the perception of stress and quality of life showed no significant differences between the groups. *Conclusion*. PEW is a potential method to reduce MSDs in workers, but it was not efficient in reducing stress levels or improving the quality of life of the workers.

- **Keywords:** cumulative trauma disorders, psychological stress, quality of life, exercise, workplace

Amir Hamta, Anoshirvan Kazemnejad, Mohammad Gholami-Fesharaki & Mohsen Rowzati. *Simultaneous effect of shift work on blood pressure and lipid profile: a path analysis*. Pages: 68-72

The aim of this study was to assess the direct and indirect effects of shift work (SW) on the systolic blood pressure (SBP) and lipid profile of male workers. For this purpose, a cross-sectional study was conducted involving 6539 male workers of Esfahan Mobarakeh Steel Company. From all of the participants, 3065 (46.8%) were day workers and the remainder were shift workers. The results of path analysis revealed that the most effective variables on SBP were body mass index, fasting blood sugar, triglycerides and SW with a total effect of 0.241, 0.095, 0.064 and 0.056, respectively.

- **Keywords:** shift work, blood pressure, lipid profile, path analysis

Albert P. Chan, Yang Yang & Wen-fang Song. *Evaluating the usability of a commercial cooling vest in the Hong Kong industries*. Pages: 73-81.Published online: 28 Feb 2017

Objective. The provision of appropriate personal cooling vests is recognized as an effective measure to combat heat stress. However, personal cooling vests are not widely implemented in the Hong Kong industries. The current study aims to evaluate the usability of a hybrid cooling vest that is associated with the success of its application in industrial settings. *Methods*. A self-administrated questionnaire focusing on 10 subjective attributes of cooling effect, ergonomic design and usability of a hybrid cooling vest was administered with 232 occupational workers in the construction, horticultural and cleaning, airport apron services and kitchen and catering industries. *Results*. A structural equation model estimated by analysis of moment structures was constructed to evaluate the usability of the cooling vest, as influenced by cooling effect and ergonomic design. Results showed that cooling effect (path coefficient = 0.69, $p < 0.001$) and ergonomic design (path coefficient = 0.55, $p < 0.001$) significantly affect the usability of the cooling vest. *Conclusions*. The structural equation model is feasible to examine the complex nature of the structural relationships among the subjective perceptions of personal cooling vests. The empirical findings furnish sound evidence for further optimization of the hybrid cooling vest in terms of cooling effect and ergonomic design for occupational workers.

- **Keywords:** cooling effect, ergonomic design, occupational workers, structural equation model

Leena Korpinen, Rauno Pääkkönen & Fabriziomaria Gobba. *Self-reported wrist and finger symptoms associated with other physical/mental symptoms and use of computers/mobile phones*. Pages: 82-90.

Recently, computer, mobile phone and Internet use has increased. This study aimed to determine the possible relation between self-reported wrist and finger symptoms (aches, pain or numbness) and using computers/mobile phones, and to analyze how the symptoms are specifically associated with utilizing desktop computers, portable computers or mini-computers and mobile phones. A questionnaire was sent to 15,000 working-age Finns (age 18–65). Via a questionnaire, 723 persons reported wrist and finger symptoms often or more with use. Over 80% use mobile phones daily and less than 30% use desktop computers or the Internet daily at leisure, e.g., over 89.8% quite often or often experienced pain, numbness or aches in the neck, and 61.3% had aches in the hips and the lower back. Only 33.7% connected their symptoms to computer use. In

the future, the development of new devices and Internet services should incorporate the ergonomics of the hands and wrists.

- **Keywords:** questionnaire study, symptom, computer

Agata Krystosik-Gromadzińska. *Ergonomic assessment of selected workstations on a merchant ship*. Pages: 91-99.

This study describes some key ergonomic factors within the engine room, navigation bridge and other locations of a merchant ship. Ergonomic assessments were carried out on a crew of a merchant ship. The study examines the importance of factors such as noise, vibration, heat radiation (in machinery areas), psychological stress and ergonomics of the physical arrangement of the navigation bridge. It also addresses the effect of working in confined areas for a long duration and the need to process large amounts of data, decision-making and the influence of specific operating conditions in different areas of a ship. This study includes analysis of workstations, working methods and the burden of environmental factors as well as a discussion of specific marine environmental conditions such as confined working and leisure spaces, long-term family and sociocultural separation, frequent changes in climate and time zones, and temporary physical overload and long-term psychological burdens.

- **Keywords:** Ergonomics, navigation bridge, engine room

Kimberly A. Meszaros, Meghan E. Vidt & Clark R. Dickerson. *The effects of hand force variation on shoulder muscle activation during submaximal exertions*. Pages: 100-110.

Upper limb injuries are highly prevalent in the workplace and new tools are needed to proactively design workstations to reduce injury risk. The objective was to characterize spatial, load and direction dependency of muscle activity for hand exertions in the upper limb workspace. Electromyographic signals were collected from 14 upper limb muscles during exertions for all combinations of 4 submaximal hand forces (20/30/50/60 N) in 6 cardinal (up/down/left/right/forward/backward) directions at 5 hand locations. Linear muscle activity increases accompanied increased hand forces. Total muscle activity increases between 20 and 60 N hand forces ranged by direction from 92% (downward) to 189% (right). Prediction equations for all muscles depended on hand force, and linear, quadratic and interaction permutations of hand location. Muscle activity associated with manual tasks is load, direction and spatially dependent. Equations developed to describe these complex relationships can be used to better design future and evaluate current occupational activities.

- **Keywords:** electromyography, upper limb, work envelope, hand force, muscle

Maria C. Gutierrez-Diez, Maria A. Benito-Gonzalez, Ramon Sancibrian, Marco A. Gandarillas-Gonzalez, Carlos Redondo-Figuero & Jose C. Manuel-Palazuelos. *A study of the prevalence of musculoskeletal disorders in surgeons performing minimally invasive surgery*. Pages: 111-117.

Introduction. Minimally invasive surgery (MIS) has shown significant benefits for patients and healthcare systems. However, due to the poor ergonomic adaptation of operating rooms and surgical instruments, most surgeons suffer from pain caused by musculoskeletal disorders (MSDs). *Methods*. A descriptive survey on MIS surgeons working in different surgical specialties has been carried out in Hospital Valdecilla (Spain). The aim is to determine the prevalence of MSDs using a personal interview and the standardized Nordic questionnaire. The study determines the prevalence of MSDs in

different parts of the body and their relationship with epidemiological and labor variables. A questionnaire was filled out by 129 surgeons. *Results*. 90% of surgeons reported MSDs. The higher prevalence appears in the most experienced surgeons. The most affected zones are the lower back (54%), neck (51%), upper back (44%), lower extremities (42%), right shoulder (29%) and right hand (28%). *Conclusions*. The prevalence of MSDs is higher in MIS surgeons than in any other occupational group. The most vulnerable group is experienced surgeons and there is a potential risk that symptoms will be increased in the future. Muscle strength is revealed as a protective factor against MSDs.

- **Keywords:** musculoskeletal disorders, minimally invasive surgery, ergonomics, endoscopy

Ashley G.B. Willmott, Alex Bliss, William H. Simpson, Steve M. Tocker, Rowland Cottingham & Neil S. Maxwell. *CAERvest® – a novel endothermic hypothermic device for core temperature cooling: safety and efficacy testing*. Pages: 118-128.

Introduction. Cooling of the body is used to treat hyperthermic individuals with heatstroke or to depress core temperature below normal for neuroprotection. A novel, chemically activated, unpowered cooling device, CAERvest®, was investigated for safety and efficacy. *Methods*. Eight healthy male participants (body mass 79.9 ± 1.9 kg and body fat percentage 16.1 ± 3.8%) visited the laboratory (20 °C, 40% relative humidity) on four occasions. Following 30-min rest, physiological and perceptual measures were recorded. Participants were then fitted with the CAERvest® proof of concept (PoC) or prototype 1 (P1), 2 (P2) or 3 (P3) for 60 min. Temperature, cardiovascular and perceptual measures were recorded every 5 min. After cooling, the CAERvest® was removed and the torso checked for cold-related injuries. *Results*. Temperature measures significantly ($p < 0.05$) reduced pre to post in all trials. Larger reductions in core and skin temperatures were observed for PoC (−0.36 ± 0.18 and −1.55 ± 0.97 °C) and P3 (−0.36 ± 0.22 and −2.47 ± 0.82 °C), compared with P1 and P2. No signs of cold-related injury were observed at any stage. *Conclusion*. This study demonstrates that the CAERvest® is an effective device for reducing body temperature in healthy normothermic individuals without presence of cold injury. Further research in healthy and clinical populations is warranted.

- **Keywords:** thermoregulation, hyperthermia, heat-related illness, cooling, targeted temperature management

Agnieszka Kulawik-Pióro, Joanna Kurpiewska & Agnieszka Kułaszka. *Rheological and sensory properties of hydrophilic skin protection gels based on polyacrylates*. Pages: 129-134.

Introduction. With the current increases in occupational skin diseases, literature data attesting the decreasing efficiency of barrier creams with respect to the manufacturer's declarations and legal regulations granting skin protection gels for employees, research is required to analyse and evaluate the recipes used for hydrophilic skin protection gels based on polyacrylates. *Methods*. This study investigated the rheological properties, pH and sensory perception of hydrophilic barrier gels based on polyacrylates. *Results*. The acrylic acid derivatives used were good thickeners, and helped to form transparent gels of adequate durability. They could be used to create hydrophilic films on the surface of the skin to protect it against hydrophobic substances. A correlation was shown between the results of the rheological properties and the barrier properties of the gels. This confirms the possibility of monitoring the quality of the gels at the stage of recipe development. *Conclusions*. Polyacrylates are viable for use in industry to produce hydrophilic barrier creams suitable for skin protection.

- **Keywords:** skin protection gels, polyacrylates, rheological and sensory measurement correlation

Bertrand Galy & André Lan. *Horizontal lifelines – review of regulations and simple design method considering anchorage rigidity*. Pages: 135-148.

Among the many occupational risks construction workers encounter every day falling from a height is the most dangerous. The objective of this article is to propose a simple analytical design method for horizontal lifelines (HLLs) that considers anchorage flexibility. The article presents a short review of the standards and regulations/acts/codes concerning HLLs in Canada the USA and Europe. A static analytical approach is proposed considering anchorage flexibility. The analytical results are compared with a series of 42 dynamic fall tests and a SAP2000 numerical model. The experimental results show that the analytical method is a little conservative and overestimates the line tension in most cases with a maximum of 17%. The static SAP2000 results show a maximum 2.1% difference with the analytical method. The analytical method is accurate enough to safely design HLLs and quick design abaci are provided to allow the engineer to make quick on-site verification if needed.

- **Keywords:** horizontal lifeline, design method, anchorage flexibility, SAP2000, fall tests, wire rope, deflection

Jean-Pierre Arz, Jean-Pierre Gettliffe & Philippe Delattre. *Effect of wearing hearing protectors on the audibility of railway warning signals – an experimental study*. Pages: 149-159.

The effect of wearing hearing protectors on the audibility of warning signals has been evaluated for three specific railway-related jobs: track workers, train drivers and platform agents. Masked thresholds were measured in the laboratory, on railway agents with normal hearing, using warning signals and background noises typical of each job. Out of the 36 situations tested in total, statistical analyses showed that wearing earplugs improves the perception in 11 situations, deteriorates the perception in 10 situations and has no significant effect in 15 situations (as compared to no hearing protector). The deteriorations essentially concern signals which have no (or not enough) energy in the low-frequency range ($f < 1500$ Hz) when they have to be heard in background noises which dominate in the low-frequency range. To prevent the deteriorations, these signals could be modified by adding some energy in the low-frequency range ($f < 1500$ Hz).

- **Keywords:** Hearing protector devices, warning signals, audibility, masked threshold

Rauno Pääkkönen & Milja Koponen. *Trends in occupational hygiene in Finland*. Pages: 160-163.

The aim of this work is to evaluate and describe the current status of, and prospects for, the future of occupational hygiene in Finland. The main sources of information include a seminar held in the annual meeting of Finnish Occupational Hygiene Society and interviews with different stakeholders. Nanotechnology and other new materials, changing work environments, circular economy including green jobs, new medical methods and advances of construction methods were recognized as future challenges. Future work opportunities for occupational hygiene experts included exposure assessments in indoor air surveys, private consulting and entrepreneurship in general, international activities and product safety issues. Unclear topics needing more attention in the future were thought to be in new exposures, sensitive persons, combined effects, skin exposures and applicability of personal protective equipment. Occupational hygiene

should broaden its view; occupational hygienists should have to cooperate with other specialists and grasp new challenges.

- **Keywords:** occupational hygiene, physical, chemical and biological factors, work environment