

Ergonomics– rok 2014, ročník 57

Číslo 10



R.J. Mitchell, A.M. Williamson, B. Molesworth & A.Z.Q. Chung. *A review of the use of human factors classification frameworks that identify causal factors for adverse events in the hospital setting.* pages 1443-1472.

Various human factors classification frameworks have been used to identify causal factors for clinical adverse events. A systematic review was conducted to identify human factors classification frameworks that identified the causal factors (including human error) of adverse events in a hospital setting. Six electronic databases were searched, identifying 1997 articles and 38 of these met inclusion criteria. Most studies included causal contributing factors as well as error and error type, but the nature of coding varied considerably between studies. The ability of human factors classification frameworks to provide information on specific causal factors for an adverse event enables the focus of preventive attention on areas where improvements are most needed. This review highlighted some areas needing considerable improvement in order to meet this need, including better definition of terms, more emphasis on assessing reliability of coding and greater sophistication in analysis of results of the classification.

Practitioner Summary: Human factors classification frameworks can be used to identify causal factors of clinical adverse events. However, this review suggests that existing frameworks are diverse, limited in their identification of the context of human error and have poor reliability when used by different individuals.

- **Keywords:** patient safety, hospital, medical errors, causal factors, reliability

Ilona Zoer, Judith K. Sluiter & Monique H.W. Frings-Dresen. *Psychological work characteristics, psychological workload and associated psychological and cognitive requirements of train drivers.* pages 1473-1487.

This study aimed to assess the psychological work characteristics and psychological workload of train drivers and to define the psychological and cognitive requirements of their work. A systematic literature search was performed, and expert interviews were conducted. The following work demands were specific to train drivers: high emotional and mental demands, small amount of autonomy and skill discretion. No evidence of a high emotional workload, a high mental workload or short-term stress reactivity was found. In general, the drivers' fatigue complaints and recovery needs after work were comparable to that of other workers. However, severe sleepiness and high need for

recovery did affect a substantial proportion of train drivers. The ability to stay aware, to anticipate, to remain attentive and to cope with fatigue are psychological and cognitive skills that are required to adequately and safely perform the train drivers' job. Including these requirements in periodic assessments of train drivers is recommended.

Practitioner Summary: A systematic literature search was performed, aimed at assessing the psychological work characteristics and psychological workload of train drivers. Based on this information and interviews with experts, a list of psychological and cognitive requirements that needed to perform the train drivers' job adequately and safely was proposed.

- **Keywords:** psychological, work, cognitive, requirements, train drivers

Patricia Hölzle, Joachim Hermsdörfer & Céline Vetter. *The effects of shift work and time of day on fine motor control during handwriting.* pages 1488-1498.

Handwriting is an elaborate and highly automatised skill relying on fine motor control. In laboratory conditions handwriting kinematics are modulated by the time of day. This study investigated handwriting kinematics in a rotational shift system and assessed whether similar time of day fluctuations at the work place can be observed. Handwriting performance was measured in two tasks of different levels of complexity in 34 shift workers across morning (6:00–14:00), evening (14:00–22:00) and night shifts (22:00–6:00). Participants were tested during all three shifts in 2-h intervals with mobile testing devices. We calculated average velocity, script size and writing frequency to quantify handwriting kinematics and fluency. Average velocity and script size were significantly affected by the shift work schedule with the worst performance during morning shifts and the best performance during evening shifts. Our data are of high economic relevance as fine motor skills are indispensable for accurate and effective production at the work place. **Practitioner Summary:** Handwriting is one of the most complex fine motor skills in humans, which is frequently performed in daily life. In this study, we tested handwriting repeatedly at the work place in a rotational shift system. We found slower handwriting velocity and reduced script size during morning shifts.

- **Keywords:** field study, fine motor control, handwriting, kinematic analysis, rotating shift

Chih-Chan Cheng, Yuh-Chuan Shih, Yue-Jin Tsai & Chia-Fen Chi. *The influence of cooling forearm/hand and gender on estimation of handgrip strength.* pages 1499-1511.

Handgrip strength is essential in manual operations and activities of daily life, but the influence of forearm/hand skin temperature on estimation of handgrip strength is not well documented. Therefore, the present study intended to investigate the effect of local cooling of the forearm/hand on estimation of handgrip strength at various target force levels (TFLs, in percentage of MVC) for both genders. A cold pressor test was used to lower and maintain the hand skin temperature at 14°C for comparison with the uncooled condition. A total of 10 male and 10 female participants were recruited. The results indicated that females had greater absolute estimation deviations. In addition, both genders had greater absolute deviations in the middle range of TFLs. Cooling caused an underestimation of grip strength. Furthermore, a power function is recommended for establishing the relationship between actual and estimated handgrip force. **Statement of relevance:** Manipulation with grip strength is essential in daily life and the workplace, so it is important to understand the influence of lowering the forearm/hand skin temperature on grip-strength estimation. Females and the middle range of TFL had greater deviations. Cooling the forearm/hand tended to cause underestimation, and a power function is recommended for establishing the relationship between actual and estimated handgrip force. **Practitioner Summary:** It is important to understand the

effect of lowering the forearm/hand skin temperature on grip-strength estimation. A cold pressor was used to cool the hand. The cooling caused underestimation, and a power function is recommended for establishing the relationship between actual and estimated handgrip force.

- **Keywords:** cold immersion, hand manipulation, handgrip-strength estimation, power function

Peng-Cheng Sung. *Effects of glovebox gloves on grip and key pinch strength and contact forces for simulated manual operations with three commonly used hand tools.* pages 1512-1525.

This study examined the effects of glovebox gloves for 11 females on maximum grip and key pinch strength and on contact forces generated from simulated tasks of a roller, a pair of tweezers and a crescent wrench. The independent variables were gloves fabricated of butyl, CSM/hypalon and neoprene materials; two glove thicknesses; and layers of gloves worn including single, double and triple gloving. CSM/hypalon and butyl gloves produced greater grip strength than the neoprene gloves. CSM/hypalon gloves also lowered contact forces for roller and wrench tasks. Single gloving and thin gloves improved hand strength performances. However, triple layers lowered contact forces for all tasks. Based on the evaluating results, selection and design recommendations of gloves for three hand tools were provided to minimise the effects on hand strength and optimise protection of the palmar hand in glovebox environments. **Practitioner Summary:** To improve safety and health in the glovebox environments where gloves usage is a necessity, this study provides recommendations for selection and design of glovebox gloves for three hand tools including a roller, a pair of tweezers and a crescent wrench based on the results discovered in the experiments.

- **Keywords:** glovebox glove, grip strength, key pinch strength, contact force, hand tool

M. Swangnetr, D. Kaber, C. Phimphasak, P. Namkorn, K. Saenlee, B. Zhu & R. Puntumetakul. *The influence of rice plow handle design and whole-body posture on grip force and upper-extremity muscle activation.* pages 1526-1535.

motivated the present experimental investigation of the influence of plow handle design and farmer whole-body posture on grip force and arm muscle activity. A total of 24 experienced farmers performed a simulated plowing task, including walking on even and uneven ground while rolling a tiller equipped with conventional horizontal and proposed vertical handles. Results revealed the proposed handles, designed to promote neutral wrist posture, to increase upper-arm muscle use between 47% and 70% across ground types, as compared with conventional handles. The ratio of grip force to forearm muscle activity (or efficiency in muscle use) increased from 1.85 when using conventional handles on uneven ground to 2.16 when using the proposed handles with symmetrical body posture on even ground. However, participants perceived higher discomfort when using the proposed handles, as they were accustomed to the conventional design. **Practitioner Summary:** The findings of this work may be used to educate farmers on the potential for hand and arm injury in rice cultivation activities. Results may also provide a basis for redesign of existing tiller handles to promote neutral wrist posture, greater efficiency in muscle use and machine control.

- **Keywords:** tool handle design, grip force, muscle activity, whole-body posture, body part discomfort

Ulrich Lindemann, Leon van Oosten, Jordi Evers, Clemens Becker, Jaap H. van Dieen & Rob C. van Lummel. *Effect of bed height and use of hands on trunk angular velocity during the sit-to-stand transfer.* pages 1536-1540.

The ability to rise from a chair or bed is critical to an individual's quality of life because it determines functional independence. This study was to investigate the effect of bed height and use of hands on trunk angular velocity and trunk angles during the sit-to-stand (STS) performance. Twenty-four older persons (median age 74 years) were equipped with a body-fixed gyroscopic sensor and stood up from a bed adjusted to different heights, with and without the use of hands at each height. Peak angular velocity and trunk range of motion decreased with increasing bed height (all $p \leq 0.038$) and were lower using hands during STS transfer indicating less effort. In conclusion, gyroscopic sensor data of the STS transfer of older persons show differences as an effect of bed height and use of hands. These results provide the rationale for recommending a relatively high bed height for most of the older persons. **Practitioner Summary:** To minimise the effort during sit-to-stand transfer performance from bed, it is necessary to understand the effect of bed height and use of hands. It is concluded that a relatively high bed height and the use of hands is helpful for most of the older persons during sit-to-stand transfer.

- **Keywords:** bed height, inertial sensor, older persons, sit-to-stand, use of hands

Morten Skandfer, Ljudmila Talykova, Tormod Brenn, Tohr Nilsson & Arild Vaktskjold. *Low back pain among mineworkers in relation to driving, cold environment and ergonomics.* pages 1541-1548.

Objectives: We aimed to study the association between low back pain (LBP) and exposure to low temperature, wet clothes, heavy lifting and jobs that involve whole body vibration (WBV) in a population of miners. *Methods:* Health and personal data were collected in a population study by a questionnaire. A total of 3530 workers from four mines participated in the study. *Results:* 51% of the workers reported LBP within the last 12 months. The adjusted odds ratio for LBP was above unity for working with wet clothes (1.82), working in cold conditions (1.52), lifting heavy (1.54), having worked as a driver previously (1.79) and driving Toro400 (2.61) or train (1.69). *Conclusion:* Wet clothing, cold working conditions, heavy lifting, previous work as a driver and driving certain vehicles were associated with LBP, but vehicles with WBV levels above action value were not. For better prevention of LBP, improved cabin conditions and clothing should be emphasised. **Practitioner Summary:** To address risk factors for low back pain (LBP) in miners, a population study measured exposures and LBP. Cold work conditions, wet clothes and awkward postures appeared to be more strongly associated with LBP than exposure to whole body vibration from driving heavy vehicles. Prevention strategies must focus more on clothing and ergonomics.

- **Keywords:** vehicle ergonomics, whole body vibration, back pain, thermal comfort, injury/illness epidemiology

M. Fard, L. Lo, A. Subic & R. Jazar. *Effects of seat structural dynamics on current ride comfort criteria.* pages 1549-1561.

The ISO 2631-1 provides methodologies for assessment of the seated human body comfort in response to vibrations. The standard covers various conditions such as frequency content, direction and location of the transmission of the vibration to the human body. However, the effects of seat structural dynamics mode shapes and corresponding resonances have not been discussed. This study provides important knowledge about the effects of vehicle seat structural vibration modes on discomfort

assessment. The occupied seat resonant frequencies and corresponding vibration modes were measured and comfort test was carried out based on the paired comparison test method. The results show that the ISO 2631-1 method significantly underestimates the vibration discomfort level around the occupied seat twisting resonant frequencies. This underestimation is mainly due to the ISO suggested location of the accelerometer pad on the seatback. The centre of the seatback is a nodal point at the seat twisting mode. Therefore, it underestimates the total vibration transferred to the occupant body from the seatback. **Practitioner Summary:** The effects of the vehicle seat structural dynamics have not been discussed in the human body vibration ISO . The results of this research show that the current measurement method suggested by ISO 2631-1 can significantly underestimate the vibration discomfort level at around the seat structural vibration mode.

- **Keywords:** vehicle seat, human vibration, resonant frequency, mode shape, ride comfort

Marcus Yung, Philip L. Bigelow, Darnell M. Hastings & Richard P. Wells. *Detecting within- and between-day manifestations of neuromuscular fatigue at work : an exploratory study. pages 1562-1573.*

Cumulative neuromuscular fatigue may result from exposure to physically demanding work, such as repetitive and/or sustained work with insufficient recovery. The aims of this exploratory study were to develop a battery of field usable fatigue measures and to document hand/arm fatigue in physically demanding work over multiple workdays and after a weekend break. Sixteen plumbers were observed for five days and measures of handgrip force, variability, tremor and discomfort were obtained pre-, mid- and post-shift. This exploratory study demonstrated increasing fatigue of the hand/arm over the day and persistent fatigue from Tuesday to Friday, and that a number of the measures did not return to baseline values following a weekend break. The findings provide preliminary evidence of cumulative fatigue in residential plumbing and insight into neuromuscular fatigue measurement. However, further work is needed to develop and refine a set of fatigue measures to detect neuromuscular fatigue at the workplace. **Practitioner Summary:** Cumulative fatigue has been linked to long-term health outcomes, including work-related musculoskeletal disorders. This paper presents findings from a physically demanding job (i.e. plumbing) revealing persistent fatigue over the work shift(s) and insufficient recovery after a weekend break, and provides insight into fatigue measurement at the workplace.

- **Keywords:** fatigue, plumbing, construction, tremor, discomfort

J. Village, M. Greig, F. Salustri, S. Zolfaghari & W.P. Neumann. *An ergonomics action research demonstration : integrating human factors into assembly design processes. pages 1574-1589.*

In action research (AR), the researcher participates 'in' the actions in an organisation, while simultaneously reflecting 'on' the actions to promote learning for both the organisation and the researchers. This paper demonstrates a longitudinal AR collaboration with an electronics manufacturing firm where the goal was to improve the organisation's ability to integrate human factors (HF) proactively into their design processes. During the three-year collaboration, all meetings, workshops, interviews and reflections were digitally recorded and qualitatively analysed to inform new 'actions'. By the end of the collaboration, HF tools with targets and sign-off by the HF specialist were integrated into several stages of the design process, and engineers were held accountable for meeting the HF targets. We conclude that the AR approach combined with targeting multiple initiatives at different stages of the design process helped the organisation find ways to integrate HF into their processes in a sustainable way. **Practitioner Summary:** Researchers acted as a catalyst to help integrate HF into the

engineering design process in a sustainable way. This paper demonstrates how an AR approach can help achieve HF integration, the benefits of using a reflective stance and one method for reporting an AR study.

- **Keywords:** macro-ergonomics, action research, human factors, ergonomics, design

A.G. Lucas-Cuevas, P. Pérez-Soriano, J.I. Priego-Quesada & S. Llana-Belloch. *Influence of foot orthosis customisation on perceived comfort during running.* pages 1590-1596.

Although running is associated with many health benefits, it also exposes the body to greater risk of injury. Foot orthoses are an effective strategy to prevent such injuries. Comfort is an essential element in orthosis design since any discomfort alters the runner's biomechanics, compromising performance and increasing the risk of injury. The present study analyses the perceived comfort of three types of orthoses: custom-made, prefabricated and original running shoe insoles. Nine comfort variables for each insole were assessed in a sample of 40 runners. Custom-made and prefabricated insoles were both perceived as significantly more comfortable than the original insoles. The differences were clinically relevant and were potentially causes of modifications in running gait. Although the prefabricated insoles were rated slightly higher than the custom-made insoles, the differences were not statistically significant. This study shows that prefabricated insoles constitute a reasonable alternative to custom-made insoles in terms of comfort. **Practitioner Summary:** The perceived level of comfort of footwear is considered to be a protective measure of the potential risk of running injuries. We here compared runners' perception of comfort of custom-made and prefabricated orthoses while running. We found that even though custom-made orthoses are closely matched to each individual's foot, such customisation does not necessarily imply greater comfort.

- **Keywords:** foot, orthoses, comfort, running