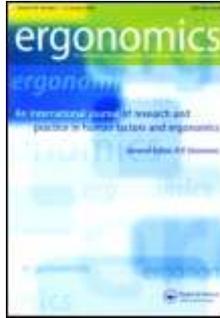


## **Ergonomics– rok 2008, ročník 51**

### **Číslo 5**



**Vincent M. Ciriello; Patrick G. Dempsey; Rammohan V. Maikala; Niall V. O'Brien. *Secular changes in psychophysically determined maximum acceptable weights and forces over 20 years for male industrial workers.* S. 593 – 601.**

The most frequent and expensive cause of compensable workplace injuries loss is manual material handling (MMH). In an attempt to minimise these losses, refinement of existing MMH guidelines is a component of redesigning high risk MMH jobs. In the development of the present MMH 1991 guidelines (Snook and Ciriello 1991), maximum acceptable weights (MAWs) and forces (MAFs) were derived from studies conducted in a 21 year time span before the above publication date. The question arises whether the present generation of workers have the same psychophysically determined weights and forces as those reflected in the guidelines. Therefore, the present study investigated whether secular changes had occurred in key MMH tasks in trials performed by present day local industrial workers. A total of 23 male industrial workers performed 20 variations of lifting, lowering, pushing, pulling and carrying tasks. A psychophysical methodology, identical to that of the authors' previous experiments, was used whereby the subjects were asked to select a workload they could sustain for 8 h 'without straining themselves or without becoming unusually tired, weakened, overheated or out of breath'. The results revealed that MAWs of lifting, lowering and carrying averaged 69% of the guideline values. MAFs of pushing and pulling showed less of a drop, averaging 82% and 94% respectively for initial and sustained forces. The results also indicated that the effects of the variables frequency, height, lifting vs. lowering, pushing vs. pulling were similar to earlier reported results, even though the absolute weights or forces were lower. It was concluded that consideration to change existing guidelines, reflecting this new psychophysical set point, may be appropriate if these significant performance decreases are confirmed in other locations, with greater subject numbers, and by other investigators.

- **Keywords:** psychophysics; manual materials handling; maximum acceptable weight and forces; ergonomic redesign

**Thomas Waters; Ash Genaidy; Heriberto Barriera Viruet; Mbulelo Makola. *The impact of operating heavy equipment vehicles on lower back disorders.* S. 602 – 636.**

Literature reviews examining the relationship between heavy equipment vehicle (HEV) operation and the development of musculoskeletal disorders have generally been

qualitative in nature and have not employed an evidence-based assessment procedure. This research determines the extent to which whole-body vibration/shock and working postures are associated with lower back and neck disorders among HEV operators, while accounting for individual (i.e. age, gender, prior history of back or neck disorders) and occupational (i.e. material handling, climatic conditions, psychosocial factors) confounders. Published articles were obtained from a search of electronic databases and from bibliographies in the identified articles. A critical appraisal of these articles was conducted using an epidemiological appraisal instrument (Genaidy *et al.* 2007). The meta-analysis was conducted using statistical techniques employing fixed-effect and random-effect models. Eighteen articles reporting observational studies satisfied the inclusion criteria adopted for this research. The methodological qualities of the published studies ranged from marginal to average. The meta-relative risk was found to be 2.21, indicating that operators exposed to driving HEVs are at more than twice the risk of developing lower back pain in comparison to those not exposed to driving HEVs. Therefore, it seems possible that there is a causal relationship between working as a HEV operator and development of lower back disorders. Prospective cohort studies are urgently needed to confirm the outcomes of this evidence-based methodology (based in part on the meta-analysis) and the biological plausibility should be further explored. The reported findings point to a need for improved ergonomic design of HEVs.

- **Keywords:** vibration; mechanical shock; musculoskeletal disorders; critical review; meta-analysis

**Heleen H. Hamberg-van Reenen; Allard J. van der Beek; Birgitte M. Blatter; Maarten P. van der Grinten; Willem van Mechelen; Paulien M. Bongers. *Does musculoskeletal discomfort at work predict future musculoskeletal pain?* S. 637 – 648.**

The objective of this prospective cohort study was to evaluate if peak or cumulative musculoskeletal discomfort may predict future low-back, neck or shoulder pain among symptom-free workers. At baseline, discomfort per body region was rated on a 10-point scale six times during a working day. Questionnaires on pain were sent out three times during follow-up. Peak discomfort was defined as a discomfort level of 2 at least once during a day; cumulative discomfort was defined as the sum of discomfort during the day. Reference workers reported a rating of zero at each measurement. Peak discomfort was a predictor of low-back pain (relative risk (RR) 1.79), neck pain (RR 2.56), right or left shoulder pain (RR 1.91 and 1.90). Cumulative discomfort predicted neck pain (RR 2.35), right or left shoulder pain (RR 2.45 and 1.64). These results suggest that both peak and cumulative discomfort could predict future musculoskeletal pain.

- **Keywords:** discomfort; low-back pain; neck pain; prediction; shoulder pain

**David M. Wilkinson; Mark P. Rayson; James L. J. Bilzon. *A physical demands analysis of the 24-week British Army Parachute Regiment recruit training syllabus.* S. 649 – 662.**

This study assessed the physical demands of the 24-week Combined Infantryman's Course (CIC) for Parachute Regiment (Para) recruits and developed physical selection standards for applicants. Fifty recruits were monitored over five separate periods (35 d in total during weeks 1-2, 5, 9, 15 and 19-20). Energy expenditure (doubly labelled water), physical activity (accelerometry) and cardiovascular strain (% heart rate reserve) were measured. There was no overall progression in both the levels of physiological stress (physical activity counts and energy expenditure) and resultant cardiovascular strain during the first nine weeks of training. Applicants' 2.4 km run time and static lift strength measured at selection predicted 10 mile loaded march performance at the end of CIC Para. The introduction of job-related selection procedures and a more progressive

approach to training has reduced the incidence of medical discharge from 14.4% to 5.1% and increased overall pass rates from 43% to 58%.

- **Keywords:** selection; military training; energy expenditure; physical activity; cardiovascular stress

**D. R. Bouchard; F. Trudeau. *Estimation of energy expenditure in a work environment: Comparison of accelerometry and oxygen consumption/heart rate regression.* S. 663 – 670**

The aim of this study was to compare estimation of energy expenditure (EE) in working environments, either from accelerometry or from an individual oxygen consumption/heart rate ( $\dot{V}O_2/HR$ ) regression curve. The study participants were 46 volunteer workers aged  $27 \pm 6$  years old. A significant correlation between EE predicted by the  $\dot{V}O_2/HR$  curve and the accelerometer was observed ( $r=0.78$ ,  $p < 0.01$ ). However, more disparities were observed between the two methods when the mean job intensity was not within 16% and 23% higher than resting HR. The accelerometer overestimated by a mean of 34.4% the prediction by  $\dot{V}O_2/HR$  regression if the intensity of the task was lower than a total of 1000 kcal/shift and underestimated the prediction by a mean of -24.9% if EE estimation of the work shift was higher than a total of 1500 kcal/shift. Despite a high correlation between both methods in the whole group, EE evaluated by accelerometry does not correspond to EE predicted by the  $\dot{V}O_2/HR$  regression curves when evaluated individually.

- **Keywords:** indirect measurement; work field; accelerometer; energy expenditure; HR monitoring

**Hwa S. Jung; Hyung-Shik Jung. *Evaluation of proper height for squatting stool.* S. 671 – 690.**

Many jobs and activities in people's daily lives have them in squatting postures. Jobs such as housekeeping, farming and welding require various squatting activities. It is speculated that prolonged squatting without any type of supporting stool would gradually and eventually impose musculoskeletal injuries on workers. This study aims to examine the proper height of the stool according to the position of working materials for the squatting worker. A total of 40 male and female college students and 10 female farmers participated in the experiment to find the proper stool height. Student participants were asked to sit and work in three different positions: floor level of 50 mm; ankle level of 200 mm; and knee level of 400 mm. They were then provided with stools of various heights and asked to maintain a squatting work posture. For each working position, they were asked to write down their thoughts on a preferred stool height. A Likert summated rating method as well as pairwise ranking test was applied to evaluate user preference for provided stools under conditions of different working positions. Under a similar experimental procedure, female farmers were asked to indicate their body part discomfort (BPD) on a body chart before and after performing the work. Statistical analysis showed that comparable results were found from both evaluation measures. When working position is below 50 mm, the proper stool height is 100 or should not be higher than 150 mm. When working position is 200 mm, the proper stool height is 150 mm. When working position is 400 mm, the proper stool height is 200 mm. Thus, it is strongly recommended to use proper height of stools with corresponding working position. Moreover, a wearable chair prototype was designed so that workers in a squatting posture do not have to carry and move the stool from one place to another. This stool should ultimately help to relieve physical stress and hence promote the health of squatting workers. This study sought to evaluate and make suggestions on user preference and BPD of proper stool height, at which work can be done comfortably, according to squatting work position. In short, results showed that proper stool height differed according to working position, even with similar squatting tasks.

- **Keywords:** squatting; stool; working posture; musculoskeletal disorders; agricultural work

**Grady T. Holman; Jerry Davis; Saeed Maghsoodloo. *The effects of dynamic movement on seated reach arcs.* S. 691 – 701.**

The objective of this study was to determine the relationship between movement of the low back and shoulder during a normal seated reach and the reach arc estimation equations found in literature. The method consisted of evaluating individuals who were reaching with their right hands for five chess pawns, which were placed at varying distances. Specifically, the pawns were evenly spaced in a straight line directly in front of each participant's shoulder. This study focused on a group of 32 participants, which included both males and females. For each participant, low back, elbow and two shoulder angles were collected using a PEAK motion capture 6.0 system. Angles were collected in both the sagittal and transverse planes to gain a 3-D perspective. Data were summarised and correlated against maximum reach arc estimates. Results from the data suggest that both the shoulder and low back are engaged much earlier in a person's reach cycle than previously believed. Specifically, the results show low back engagement (trunk/lumber flexion) as early as 50% of maximum reach with the angle increasing to 5° at around 80% and 10° at 93%, which allows more pronounced forward angular acceleration. This shifts the shape and effective area of a participant's reach arc to a 'dynamic' state and questions if major muscle recruitment in the torso has initiated. The resulting effect is that dynamic and static reach arcs may vary significantly. While this study is too limited to support formal conclusions, these results strongly suggest a need for further investigation into the limits and impact of dynamic reach.

- **Keywords:** dynamic; reach arc; seated; shoulder; back; layout

**Maranda McBride; Tomasz Letowski; Phuong Tran. *Bone conduction reception: Head sensitivity mapping.* S. 702 – 718.**

This study sought to identify skull locations that are highly sensitive to bone conduction (BC) auditory signal reception and could be used in the design of military radio communication headsets. In Experiment 1, pure tone signals were transmitted via BC to 11 skull locations of 14 volunteers seated in a quiet environment. In Experiment 2, the same signals were transmitted via BC to nine skull locations of 12 volunteers seated in an environment with 60 decibels of white background noise. Hearing threshold levels for each signal per location were measured. In the quiet condition, the condyle had the lowest mean threshold for all signals followed by the jaw angle, mastoid and vertex. In the white noise condition, the condyle also had the lowest mean threshold followed by the mastoid, vertex and temple. Overall results of both experiments were very similar and implicated the condyle as the most effective location.

- **Keywords:** hearing threshold; radio communication; noise; bone vibration

**S. J. Schlittmeier; J. Hellbrück; R. Thaden; M. Vorländer. *The impact of background speech varying in intelligibility : effects on cognitive performance and perceived disturbance.* S. 719 – 736.**

Noise abatement in office environments often focuses on the reduction of background speech intelligibility and noise level, as attainable with frequency-specific insulation. However, only limited empirical evidence exists regarding the effects of reducing speech intelligibility on cognitive performance and subjectively perceived disturbance. Three experiments tested the impact of low background speech (35 dB(A)) of both good and poor intelligibility, in comparison to silence and highly intelligible speech not lowered in level (55 dB(A)). The disturbance impact of the latter speech condition on verbal short-term memory ( $n = 20$ ) and mental arithmetic ( $n = 24$ ) was significantly reduced during

soft and poorly intelligible speech, but not during soft and highly intelligible speech. No effect of background speech on verbal-logical reasoning performance ( $n = 28$ ) was found. Subjective disturbance ratings, however, were consistent over all three experiments with, for example, soft and poorly intelligible speech rated as the least disturbing speech condition but still disturbing in comparison to silence. It is concluded, therefore, that a combination of objective performance tests and subjective ratings is desirable for the comprehensive evaluation of acoustic office environments and their alterations.

- **Keywords:** office noise; cognitive performance; irrelevant speech; speech intelligibility; noise abatement; auralisation

**P. S. Paul; J. Maiti. *The synergic role of sociotechnical and personal characteristics on work injuries in mines. S. 737 – 767.***

Occupational injuries in mines are attributed to many factors. In this study, an attempt was made to identify the various factors related to work injuries in mines and to estimate their effects on work injuries to mine workers. An accident path model was developed to estimate the pattern and strength of relationships amongst the personal and sociotechnical variables in accident/injury occurrences. The input data for the model were the correlation matrix of 18 variables, which were collected from the case study mines. The case study results showed that there are sequential interactions amongst the sociotechnical and personal factors leading to accidents/injuries in mines. Amongst the latent endogenous constructs, job dissatisfaction and safe work behaviour show a significant positive and negative direct relationship with work injury, respectively. However, the construct safety environment has a significant negative indirect relationship with work injury. The safety environment is negatively affected by work hazards and positively affected by social support. The safety environment also shows a significant negative relationship with job stress and job dissatisfaction. However, negative personality has no significant direct or indirect effect on work injury, but it has a significant negative relationship with safe work behaviour. The endogenous construct negative personality is positively influenced by job stress and negatively influenced by social support.

- **Keywords:** occupational injury; sociotechnical model; structural equation modelling