Reviews


Musculoskeletal disorders (MSDs) affect much of the workforce and remain a major form of occupational ill health. With a view to improving the efficacy of interventions, this review examined preventative actions relating to these disorders. A detailed analysis grid was used to classify the information contained in the 47 reviewed articles whose common aspect was to report actions carried out in the workplace that led to the implementation of changes to prevent MSDs. The analysis identified and characterized three major categories of intervention processes in MSD prevention: the complete type (n=17), the shortened type (n=16), and the turnkey type (n=14). These three groups of intervention processes were differentiated by their approaches and their contexts of application. The result was important differences in the changes implemented. Because of the variability in intervention processes and possible impacts on MSD prevention, a proposal to "delimit" these processes so as to improve their effectiveness is presented.

Keywords: Workplace; Intervention processes; Changes

Summary: http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6V1W-4NRCRXK-1&_user=10&_coverDate=01%2F31%2F2008&_rdoc=2&_fmt=summary&_orig=browse&_srch=docinfo(%23toc%235685%23232008%23999609998%2368997%23FLA%23display%23Volume)&_cdi=5685&_sort=d&_docanchor=&_ct=16&_acct=C000050221&_version=1&_userid=10&md5=c24346f3f04c41da041efe3fecc5e260

Mike Kolich. A conceptual framework proposed to formalize the scientific investigation of automobile seat comfort. Pages 15-27.

Consumer expectations for automobile seat comfort continue to rise. With this said, it is evident that the current automobile seat comfort development process, which is only sporadically successful, needs to change. In this context, there has been growing recognition of the need for automobile seat comfort researchers to establish a theoretical and methodological foundation. Only in this way can automobile seat comfort achieve recognition as a true scientific discipline and enable its further development. The present
contribution hopes to stimulate and lead researchers to focus on a framework through which this recognition and development can take place. This paper describes the current automobile seat comfort development process and details the associated limitations. The limitations were the catalysts for the creation of a systematized framework intended to direct the investigative process associated with seat comfort research. The framework is expected to produce theories and methods that can explain, guide, and further legitimize the discipline of automobile seat comfort.

- **Keywords:** Automobile seat comfort; Theory; Methodology; Conceptual framework

- **Summary:** http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6V1W-4N977K3-2&_user=10&_coverDate=01%2F31%2F2008&_rdoc=3&_fmt=summary&_orig=browse&_origin=&_docanchor=&_docanchor=&_ct=16&_acct=C000050221&_version=1&_urlVersion=0&_userid=10&md5=e282294a3d75178b5812bbe1b4f839aa

**Regular Papers**

**Diane E. Gregory, Stephan Milosavljevic, Poonam Pal and Jack P. Callaghan.** An examination of shoulder kinematics and kinetics when using a commercial trunk harness while sheep shearing. Pages 29-35.

Sheep shearing is a very physically demanding occupation, especially on the low back, such that many commercial harnesses have been developed to help reduce the load on the back. Such harnesses have been shown to significantly reduce peak and cumulative low back loads; however, the effect that these harnesses have on the shoulders, which are also highly involved during sheep shearing, has not been previously examined. The purpose of this study was to examine the shoulder postures and cumulative shoulder moments of 12 New Zealand sheep shearers. The use of the trunk harness reduced the percentage of time spent in shoulder flexion greater than 90° and the time spent in shoulder abduction greater than 45° as well as reduced the cumulative net joint flexor, abductor, and adductor shoulder moments by a minimum of 21%, 14%, and 42%, respectively. Therefore, the use of a commercial trunk harness to reduce low back injury may also help to reduce the risk of shoulder injury while sheep shearing.

- **Keywords:** Sheep shearing; Shoulder biomechanics; Trunk harness

- **Summary:** http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6V1W-4P0N90P-1&_user=10&_coverDate=01%2F31%2F2008&_rdoc=4&_fmt=summary&_orig=browse&_origin=&_docanchor=&_docanchor=&_ct=16&_acct=C000050221&_version=1&_urlVersion=0&_userid=10&md5=705273df3b636ea39758272289dbe8e

**Gongbing Shan.** Biomechanical evaluation of bike power saver. Pages 37-45.

Bike power saver (BPS) is a new product that claims to change the angle of pedaling forces and reduce applied power dead range (Chic Sheng Industrial Co., Ltd, Taiwan, China). In order to determine its effectiveness, we quantified how BPS operates through a 3D kinematical study and electromyography (EMG) analysis of leg muscles during pedaling. Ten kinesiology students participated in this study. A 3D motion capture system consisting of nine high-speed cameras (VICON v8i, a capture rate of
120 frames/s) was used to collect the total body and pedal motion with and without BPS at statically determined low, middle and high intensity cycling levels. The short-time test (14 s) was applied to all intensity levels while the long-time test (30 min) was applied only to the low wattage level. Wireless EMG was synchronized with the 3D motion capture system to monitor the right and left tibialis anterior, gastrocnemius, quadriceps and hamstring. The results revealed that BPS did not alter hip and knee movement significantly ($p>0.05$), but it did vary ankle movement. BPS caused a movement change in the pedals, and consequently induced instability in ankle control. The altered pedal movement led to an increase in activity level and presumably also energy expenditure for dominant muscles, resulting in a faster fatigue process. From these data, it is likely that the BPS actually requires more effort than a standard bike.

- **Keywords:** 3D motion capture; Joint control; Electromyography; Frequency analysis; Fatigue; Efficiency

- **Summary:** http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6V1W-4NT2521-1&_user=10&_coverDate=01%2F31%2F2008&_rdoc=5&_fmt=summary&_orig=browse&_srch=docinfo(%23toc%23235685%23232008%233999609998%23668997%23FLA%23display%23Volume)&_cdi=5685&_sort=d&_docanchor=&_ct=16&acct=C000050221&version=1&_urlVersion=0&_userid=10&md5=d52fcdcb8f12feb99fcd9fa538a477


The paper discusses a series of driving trials that were conducted to investigate postural stability of disabled drivers and to assess the effectiveness of a representative sample of support aids. Twenty-three disabled drivers with varying levels of physical disability and seven non disabled drivers participated in the study. The test car was equipped with transducers to measure vehicle velocity and acceleration (longitudinal and lateral), steering wheel movement and torque, and the bracing forces exerted by the driver on the steering wheel. Video cameras were installed to record postural support strategies and displacement of the driver and to record deviation of the car from the specified path. Subjective data regarding driver attitudes and acceptance were also collected through the administration of questionnaires. Findings from the study showed that support aids significantly improved driving performance and reduced physical exertion to maintain an upright driving position for disabled drivers. However, ergonomics design aspects regarding the ease of use and acceptance of the support aids by the end users were identified as obstacles to their sustained use in everyday driving.

- **Keywords:** Disabled; Drivers; Posture

- **Summary:** http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6V1W-4NW1HBM-1&_user=10&_coverDate=01%2F31%2F2008&_rdoc=6&_fmt=summary&_orig=browse&_srch=docinfo(%23toc%23235685%23232008%233999609998%23668997%23FLA%23display%23Volume)&_cdi=5685&_sort=d&_docanchor=&_ct=16&acct=C000050221&version=1&_urlVersion=0&_userid=10&md5=4594c71e8c1c523b97907ff0588e76f4

Geoffrey David, Valerie Woods, Guangyan Li and Peter Buckle. The development of the Quick Exposure Check (QEC) for assessing exposure to risk factors for work-related musculoskeletal disorders. Pages 57-69.
This paper describes the development and evaluation of the Quick Exposure Check (QEC), which is an observational tool developed for Occupational Safety and Health (OSH) practitioners to assess exposure to risks for work-related musculoskeletal disorders and provide a basis for ergonomic interventions. The tool is based on epidemiological evidence and investigations of OSH practitioners’ aptitudes for undertaking assessments. It has been tested, modified and validated using simulated and workplace tasks, in two phases of development, with participation of 206 practitioners. The QEC allows the four main body areas to be assessed and involves practitioners and workers in the assessment. Trials have determined its usability, intra- and inter-observer reliability, and validity which show it is applicable to a wide range of working activities. The tool focuses primarily on physical workplace factors, but also includes the evaluation of psychosocial factors. Tasks can normally be assessed within 10 min. It has a scoring system, and exposure levels have been proposed to guide priorities for intervention. Subsequently it should be used to evaluate the effectiveness of any interventions made. The QEC can contribute to a holistic assessment of all the elements of a work system.

- **Keywords:** Ergonomics; Measurement; Workplace

- **Summary:** [Link](http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6V1W-4NS36G5-2&_user=10&_coverDate=01%2F31%2F2008&_rdoc=7&_fmt=summary&_orig=browse&_srch=docinfo(%23toc%235685%23232008%233999609998%233668997%23FLA%23display%23Volume)&_cdi=5685&_sort=d&docanchor=&_ct=16&acct=C000050221&version=1&_urlVersion=0&_userid=10&md5=124ecfb7203706a12893a055e8103881)

**Juergen Sauer, Holger Franke and Bruno Ruettinger.** **Designing interactive consumer products: Utility of paper prototypes and effectiveness of enhanced control labelling.** Pages 71-85.

The studies reported here examined differences in user behaviour when presented with a low-fidelity paper prototype compared to fully operational product, and evaluated the effectiveness of different types of enhanced labelling of controls. In the first study with a paper prototype, 30 users of high-pressure washers were asked to choose the settings of the temperature control for different cleaning objects, comparing standard with information-enriched control labelling. In the second study, 34 users operated a real high-pressure washer with different forms of control labelling. The results of both studies provided evidence for some benefits of an information-enriched control labelling over traditional temperature-centred controls labelling. Furthermore, a comparative analysis of the data of the two studies suggested that low-fidelity paper prototypes may have to be used with caution. Therefore, designers need to be aware that the behavioural effects induced by different design modifications may be overestimated when using paper prototypes. The implications of the findings are discussed within the framework of an enlarged concept of fidelity.

- **Keywords:** Paper prototype; Simulation fidelity; Consumer product

- **Summary:** [Link](http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6V1W-4NP9KH8-2&_user=10&_coverDate=01%2F31%2F2008&_rdoc=8&_fmt=summary&_orig=browse&_srch=docinfo(%23toc%235685%23232008%233999609998%233668997%23FLA%23display%23Volume)&_cdi=5685&_sort=d&docanchor=&_ct=16&acct=C000050221&version=1&_urlVersion=0&_userid=10&md5=85afcd22b83d45bb7d4b29f1e654a2f6)

**Peregrin Spielholz, Ninica Howard, Ernesto Carcamo and Bruce Coulter.** **Field evaluation of a new grocery checkstand design.** Pages 87-91.
A novel express checkstand with basket cut-out was developed and evaluated in a small grocery store chain. Eight checkers performed three trials of simulated grocery checkout work with actor customers using both old and new checkstand designs. Usability was assessed by survey, structured interview and observation. Time–motion video analysis was used to evaluate differences in body postures, motions, and productivity. The new express checkstand design, which lowered and angled the presentation of the grocery basket, significantly (\textit{p}<0.05) reduced right wrist flexion duration and repetition, and right arm elevation repetition. No significant differences were found in job cycle time between designs. These results demonstrate the utility of a new express checkstand design that could reduce extreme postures and motions with no loss in productivity.

- **Keywords:** Grocery checkstand; Design; Injury risk factors; Usability
- **Summary:** [http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6V1W-4NJX49J-1&_user=10&_coverDate=01%2F31%2F2008&_rdoc=9&_fmt=summary&_orig=browse&_srch=doc-info(%23toc%2323685%23232008%233999609998%233668997%23FLA%2323display%23Volume)&_cdi=5685&_sort=d&_docanchor=&_ct=16&_acct=C000050221&_version=1&_userid=10&md5=469bd5313711f0d4253c86ca8f24a263](http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6V1W-4NJX49J-1&_user=10&_coverDate=01%2F31%2F2008&_rdoc=9&_fmt=summary&_orig=browse&_srch=doc-info(%23toc%2323685%23232008%233999609998%233668997%23FLA%2323display%23Volume)&_cdi=5685&_sort=d&_docanchor=&_ct=16&_acct=C000050221&_version=1&_userid=10&md5=469bd5313711f0d4253c86ca8f24a263)


Obesity in the workforce is a growing problem worldwide. While the implications of this trend for biomechanical loading of the musculoskeletal system seem fairly straightforward, the evidence of a clear link between low back pain (LBP) and body mass index (BMI) (calculated as whole body mass in kilograms divided by the square of stature in meters) has not been shown in the epidemiology literature addressing this topic. The approach pursued in the current study was to evaluate the lifting kinematics and ground reaction forces of a group of 12 subjects—six with a BMI of less than 25 kg/m² (normal weight) and six with a BMI of greater than 30 kg/m² (obese). These subjects performed a series of free dynamic lifting tasks with varied levels of load (10% and 25% of capacity) and symmetry (sagittally symmetric and 45° asymmetric). The results showed that BMI had a significant effect (\textit{p}<0.05) on trunk kinematics with the high BMI group exhibiting higher peak transverse plane (twisting) velocity (59% higher) and acceleration (57% higher), and exhibiting higher peak sagittal plane velocity (30% higher) and acceleration (51% higher). When normalized to body weight, there were no significant differences in the ground reaction forces between the two groups. This study provides quantitative data describing lifting task performance differences between people of differing BMI levels and may help to explain why there is no conclusive epidemiological evidence of a relationship between BMI and LBP.

- **Keywords:** Obesity; Lifting; Low back pain
- **Summary:** [http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6V1W-4NCKKK0V-1&_user=10&_coverDate=01%2F31%2F2008&_rdoc=10&_fmt=summary&_orig=browse&_srch=doc-info(%23toc%2323685%23232008%233999609998%233668997%23FLA%2323display%23Volume)&_cdi=5685&_sort=d&_docanchor=&_ct=16&_acct=C000050221&_version=1&_userid=10&md5=6ef14551027f6d3fff87af51d0398b59](http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6V1W-4NCKKK0V-1&_user=10&_coverDate=01%2F31%2F2008&_rdoc=10&_fmt=summary&_orig=browse&_srch=doc-info(%23toc%2323685%23232008%233999609998%233668997%23FLA%2323display%23Volume)&_cdi=5685&_sort=d&_docanchor=&_ct=16&_acct=C000050221&_version=1&_userid=10&md5=6ef14551027f6d3fff87af51d0398b59)

The study examined the consequences of working conditions on the previous day on cognitive performance the following day. It also addressed the issue of whether this relationship was mediated by sleep and whether it differed as a function of age. The data were taken from the VISAT study (aging, health and work) and concerned the participant’s general work schedule, general sleep quality, working conditions on the previous day (content, duration, load and schedule), subsequent sleep length and quality, and cognitive performance. Results showed that both physical activity and working before 6 am or after 10 pm on the previous day were significantly associated with poorer cognitive performance. Significant effects of working conditions on the previous day were also observed on subsequent sleep, but these effects did not mediate the relationship between working conditions and cognitive performance. The observed effect on cognitive performance of atypical work hours on the previous day was similar for all ages, probably because of the healthy worker effect.

**Keywords:** Age; Shift work; Cognitive performance

**Summary:**

http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6V1W-4NH6CWJ-1&_user=10&_coverDate=01%2F31%2F2008&_rdoc=11&_fmt=summary&_orig=browse&_srch=docinfo%23toc%235685%23232008%23999609998%2368997%23FLA%23display%23Volume)&_cdi=5685&sort=d&docanchor=&_ct=16&acct=C000050221&_version=1&_urlVersion=0&_userid=10&md5=183d21df1dc7dd295f7b40721daf22f


Two-button computer mouse users may exhibit sustained, static finger lifting behaviours to prevent inadvertent activations by avoiding finger pressure on the buttons, which leads to prolonged, static finger extensor muscle loading. One hundred graduate students were observed during normal computer work in a university computer facility to qualify and quantify the prevalence of lifted finger behaviours and extended finger postures, as well as wrist/forearm and grip behaviour, during specific mouse activities. The highest prevalences observed were 48% of the students lifted their middle finger during mouse drag activities, and 23% extended their middle finger while moving the mouse. In addition, 98% of the students rested their wrist and forearm (77%) or wrist only (21%) on the workstation surface, and 97% had an extended wrist posture (15°–30°) when using the mouse. Potential applications of these findings include future computer input device designs to reduce finger lifting behaviour and exposures to risk factors of hand/forearm musculoskeletal pain.

**Keywords:** Finger behaviour; Computer mouse use; Finger lifting prevalence

**Summary:**

http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6V1W-4ND710D-1&_user=10&_coverDate=01%2F31%2F2008&_rdoc=12&_fmt=summary&_orig=browse&_srch=docinfo%23toc%235685%23232008%23999609998%2368997%23FLA%23display%23Volume)&_cdi=5685&sort=d&docanchor=&_ct=16&acct=C000050221&_version=1&_urlVersion=0&_userid=10&md5=ddae3d488ee75b9ce2a7121d0bd58b37

Bor-Shong Liu. *Incorporating anthropometry into design of ear-related products.* Pages 115-121.

To achieve mass customization and collaborative product design, human factors and ergonomics should play a key development role. The purpose of this study was to provide product designers with the anthropometric dimensions of outer ears for different
demographic data, including gender and age. The second purpose was to compare the dimensions of various ear-related products (i.e., earphone, bluetooth earphone and ear-cup earphone) with the anthropometric database and recommend appropriate solutions for design. Two hundred subjects aged 20–59 was selected for this study and divided into four age stratifications. Further, three different dimensions of the outer ear (i.e., the earhole length, the ear connection length and the length of the pinna) were measured by superimposed grid photographic technique. The analysis of variance (ANOVA) was used to investigate the effects of gender, and age on ear dimensions. The results showed that all ear dimensions had significant gender effects. A comparison between the anthropometric dimensions and those of current products revealed that most current ear-related products need to be redesigned using anthropometric data. The shapes of earhole and pinna are not circular. Consequently, ear products need to be elongated so that users may feel more comfortably and not have the product slip off easily.

- **Keywords:** Anthropometry; Ear dimensions; Ear-related products

- **Summary:** [http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6V1W-4N97BPZ-1&_user=10&_coverDate=01%2F31%2F2008&_rdoc=13&_fmt=summary&_orig=browse&_sort=docinfo%23toc%235685%23196809998%23665997%23FLA%23display%23Volume)&_cdi=5685&_sort=d&_docanchor=&_ct=16&_acct=C000050221&_version=1&_urlVersion=0&_userid=10&md5=ed7f0c8adac03448d8dea3d8b30e6f52](http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6V1W-4N97BPZ-1&_user=10&_coverDate=01%2F31%2F2008&_rdoc=13&_fmt=summary&_orig=browse&_sort=docinfo%23toc%235685%23196809998%23665997%23FLA%23display%23Volume)&_cdi=5685&_sort=d&_docanchor=&_ct=16&_acct=C000050221&_version=1&_urlVersion=0&_userid=10&md5=ed7f0c8adac03448d8dea3d8b30e6f52)

Miguel López-Torres, Rosa Porcar, José Solaz and Tomás Romero. **Objective firmness, average pressure and subjective perception in mattresses for the elderly.** Pages 123-130.

For elderly people, the desirable situation of living independently means facing everyday tasks and risks alone [Monk et al., 2006. Towards a practical framework for managing the risks of selecting technology to support independent living. Appl. Ergon. 37, 599–606]. One such task is buying a mattress through the same channels as younger people. Quite short trials (if any) in the store are usually the only basis for choice. Despite the long-term effects a mattress may have on the user, acceptance or rejection largely depends on this extremely short trial experience. This paper aims to cover the salient mechanical aspects of comfort and usability (rolling, getting up). The results should help manufacturers to know if the long-term benefits of their products are perceived in the short term by senior citizen customers. Four mattresses for the elderly chosen from a sample of 17 available on the Spanish market were compared in pairs for short-term effects (1 min pressure with both hands, 1 min sitting, 1 min lying on back, and 1 min lying on side), simulating a store purchasing trial by a group of young and elderly people in terms of differences between perceived firmness, usability (ease of movement) and comfort. The results of these comparisons were correlated to differences in objective properties such as pressure distribution and objective firmness. No differences in perception were found between young and old users. Only two of the four test methods for perceiving mattress firmness were necessary to explain the majority of variance: pressing the surface of the mattress with a part of the body (both hands or buttocks), and contact using the entire body (lying on back or side). A number of significant relationships were found, with the following of note: increments in ‘objective firmness’ (estimated from test load/deflection) correlate positively to increments in ‘perceived firmness’; increments in ‘average pressure’ (measured using a mannequin) correlate positively to increments (within certain limits) in ‘perceived firmness’; increments in ‘objective firmness’ and in ‘average pressure’ are associated with increments in ‘overall comfort’ and with reductions in ‘difficulty in rolling”. Finally, it was found that people with a higher body mass index tend to be (weak correlation) more sensitive to changes in ‘objective firmness’.
Keywords: Mattress; Firmness; Pressure distribution; Comfort; Elderly; Usability

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Technical Note

T.P. Hutchinson. On ratings of comfort and exertion by visual display unit users and ratings of workplace layout and working posture by expert ergonomists. Pages 131-132.

Data sets comparing ratings of comfort and perceived exertion by visual display unit (VDU) users with ratings of workplace layout and working posture by expert ergonomists were published by Lindegard et al. [2005. Concordance between VDU-users’ ratings of comfort and perceived exertion with experts’ observations of workplace layout and working postures. Appl. Ergon. 36, 319–325]. The present paper corrects the conclusions that were drawn. Users’ and experts’ ratings were very largely independent of each other. It is also noted that polychoric correlation is often an appropriate statistic for summarising the association in ordered tables of frequencies.

Keywords: VDU work; Ratings (judgments); Polychoric correlation; Expert opinions; Validity of ratings

Summary: http://www.sciencedirect.com/science?ob=ArticleURL&udi=B6V1W-4NBRFVR-1&user=10&coverDate=01%2F31%2F2008&rdoc=15&fmt=summary&orig=browse&srch=docinfo(%23toc%2323685%23232008%23999609998%2368997%23FLA%23display%23Volume)&cdi=5685&sort=d&docanchor=&ct=16&acct=C000050221&version=1&urlVersion=0&userid=10&md5=b953e907aae2b0b37dfe45ca20104ebb