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**Shuping Xiong, Ravindra S. Goonetilleke, W.D. Asanka S. Rodrigo, Jianhui Zhao. *A model for the perception of surface pressure on human foot.* Pages 1-10.**

The psychophysical relationship between the magnitude of pressure on thirteen test locations of twenty healthy subjects' feet with four probe areas at three indentation speeds and the corresponding perceived sensations were analyzed. The dependency of pressure pain thresholds (PPT) on area,  $A$ , and speed,  $v$ , can be mathematically modeled in the form,  $PPT_i = [a_i + b \ln(v)] A^\beta i = 1, 2, \dots, 13$  where  $\beta$  and  $b$  are constants and are dependent on location and gender, and  $a_i$  is a constant highly correlated with foot tissue stiffness.

The relationship between the sensory intensity to pressure magnitude appears to follow a modified Stevens' power law with power exponents less than 1.0 and consistent across the 13 test locations with a mean of 0.82 and a range from 0.67 to 0.98. This particular model helps to understand the sensation of pressure threshold and its impact in the design of consumer products.

- **Keywords:** Perception; Pain threshold; Foot

**Sandra Schwanitz, Martin Wittkowski, Vinzent Rolny, Christina Samel, Mathias Basner. *Continuous assessments of pressure comfort on a train – A field-laboratory comparison.* Pages 11-17.**

Pressure variations on a train predominantly occur while trains are passing through tunnels. These aerodynamic effects may give rise to aural discomfort in railway passengers. We conducted a field study on the high speed railway track Cologne-Frankfurt/Main as well as a simulation study in our pressure chamber TITAN (DLR-Institute of Aerospace Medicine) with 31 subjects (mean age = 37.7,  $SD = 12.7$ ; 51.6% male) to investigate pressure comfort for passengers. Continuous assessments of pressure events using sliders and retrospective assessments were acquired. Pressure variations were mostly tolerated. A comparison of field and laboratory setting revealed high congruency of continuous as well as retrospective assessments. A generalized estimating equation model identified pressure change attributes contributing to passengers' discomfort. Beside attributes of instantaneous pressure changes (e.g. high amplitudes, short durations), pressure events of the recent past significantly influenced current discomfort. Design engineers may use these findings to improve train and tunnel design.

- **Keywords:** Pressure variation; Passenger comfort; Railway

**A. Yoxall, E.M. Rodriguez-Falcon, J. Luxmoore. *Carpe diem, Carpe ampulla: A numerical model as an aid to the design of child-resistant closures.* Pages 18-26.**

The population of most developed countries is ageing. Despite continuing medical advances, ageing brings with it a host of issues, not least a loss in strength and dexterity. One major area of concern is the ability of elderly consumers to access packaged goods such as food and medicines. In previous studies, the authors developed a numerical model of a human hand that was used to investigate the effect of physical dimensions and choice of grip on joint stresses to aid the understanding between physical effort, ability and discomfort. This previous work was supported by ethnographic studies and led to recommendations for packaging design.

In this paper, a small ethnographic study is undertaken which identifies the grip types used to access to a product that is known to cause particular difficulties for the elderly, the "squeeze and turn" child-resistant closure or CRC, commonly used on medicines and cleaning products. One of the grip types used was chosen to be modelled using the numerical model developed in previous studies by the author. Model geometry and loading were adapted to simulate the "squeeze and turn" nature of the initial opening for closures of this type. A series of studies were then undertaken using different hand geometries; an average male hand, an average female hand and a fifth percentile female hand.

The prediction from the model here is that female users with smaller hands will experience more discomfort when accessing squeeze and turn CRC's and that the turn process whilst maintaining the squeeze is problematic.

- **Keywords:** Openability; Packaging; Biomechanics

**Glyn Lawson, Sarah Sharples, David Clarke, Sue Cobb. *Validating a low cost approach for predicting human responses to emergency situations.* Pages 27-34.**

This paper presents a new approach for predicting human responses to emergency situations. The approach was developed for ergonomists working in emergency response preparedness. It involves presenting participants with a description of a hypothetical emergency scenario before asking them to describe how they would respond. This study builds upon previous investigations ([Lawson et al., 2009a](#), [2009b](#); [Lawson, 2011](#)) which demonstrated significant associations between the predicted behaviour and that reported in a reference study of behaviour in real fires. This further work aimed to evaluate in greater detail the validity, reliability, resources and ethics of the approach. The results demonstrated significant relationships between the predicted behaviours and those from the reference study for both frequencies ( $r_s = 0.572$ ,  $N = 51$ ,  $p < 0.001$ ) and sequences ( $r_s = 0.344$ ,  $N = 40$ ,  $p < 0.05$ ) of behaviour. The approach is shown to be replicable and requires low resources. It does not present any notable risk of physical injury.

- **Keywords:** Emergency; Response; Behaviour

**Peter W. Johnson, Vincent M. Ciriello, Kirsty J. Kerin, Jack T. Dennerlein. *Using electrical stimulation to measure physiological changes in the human extensor carpi ulnaris muscle after prolonged low-level repetitive ulnar deviation.* Pages 35-41.**

The objective of this study was to determine whether muscle fatigue would result from repetitive voluntary contractions performed consecutively over four, 8-h workdays. Using a repeated measures design, ten healthy females participated in three conditions: a

control and two repetitive work conditions involving 8 h of repeated ulnar deviation of the wrist, at self-selected workloads at 20 and 25 repetitions per minute (RPM). The 2, 20 and 50 Hz force response of the Extensor Carpi Ulnaris muscle was measured before, during work, and in three hours of recovery. Twitch contraction times (CT), one-half relaxation times ( $\frac{1}{2}$  RT) and 20:50 Hz ratios (low frequency fatigue ratios) were also compared. The average workloads for the 20 and 25 RPM conditions were 20.3% ( $\pm 11.6\%$ ) and 16.3% ( $\pm 10.8\%$ ) MVC respectively. In the exposure conditions there was a decrease in the 20:50 Hz ratios indicating low frequency fatigue (LFF), a significant increase in the muscle's force response across all stimulation frequencies (potentiation), and a corresponding decrease (quickenings) in the twitch CTs and  $\frac{1}{2}$  RTs. During recovery, the 20:50 Hz ratios, muscle forces and twitch CTs and  $\frac{1}{2}$  RTs returned to pre-exposure/baseline levels. There were no carryover effects or significant differences between the two consecutive workdays. For the low-level dynamic workloads tested in this study, LFF coexisted with muscle potentiation and the results indicated that both LFF ratios and the individual force responses at each frequency needs to be evaluated in order to understand the underlying state of the muscle.

- **Keywords:** Muscle fatigue; Upper extremities; Potentiation; Low frequency fatigue

**Maurice F. Donoghue, David S. O'Reilly, Michael T. Walsh. *Wrist postures in the general population of computer users during a computer task.* Pages 42-47.**

Computer activities have commonly been linked to the development of musculoskeletal disorders (MSDs) in the upper limbs. However, to understand the effects computer use has on such disorders, it is necessary to identify and classify the movements involved in performing common computer tasks, one of these being typing. Motion analysis techniques were adopted to determine the movements involved during a typing task. This involved markers being placed on the knuckles, wrists and forearms of participants. This marker configuration allowed for the flexion, extension, radial deviation, ulnar deviation and a combination of these movements to be calculated. The results in one plane of motion show a mean extension|flexion and radial|ulnar deviation of  $18.825^\circ \pm 10.013^\circ$  and  $5.228^\circ \pm 11.703^\circ$  respectively. The most common position in two planes of motion was  $20^\circ$  extension with a simultaneous  $20^\circ$  ulnar deviation (10.72%). The results depict an alternative method of categorizing wrist positions in two planes during computer use. Coincident wrist postures should be addressed as opposed to motion in a single plane as these postures may result in different ergonomic risk factors developing.

- **Keywords:** Typing tasks; Musculoskeletal disorders; Wrist posture

**Jon Boyer, Jia-hua Lin, Chien-chi Chang. *Description and analysis of hand forces in medicine cart pushing tasks.* Pages 48-57.**

The primary objectives of this study were to describe and analyze the hand force exertion patterns of experienced nursing home nurses and nursing students during dynamic medicine cart pushing tasks in Initial, Sustained, Turning, and Stopping motion phases. A  $2 \times 2 \times 2$  factorial experiment was conducted with 22 participants to estimate the effects of lane congestion, precision cart control, and floor surface on horizontal hand forces. Root mean squared (RMS) lane deviation patterns were also described to provide an indicator of cart handling difficulty across the different study conditions. Descriptive statistics revealed that nurses exerted greater mean hand force (10%) and made more (12%) lane deviation than students and that the highest two-hand forces of 147N were measured in the Turning phase on carpet. Strong correlations between work experience group, body mass, and BMI required that force data for nurses and students be collapsed in analytical models where no group differences existed. Predicted pushing forces on

carpeted floor surface were significantly greater than on tile in Initial (14N), Sustained (14N) and Turning (18N), except in stopping where pulling forces were 37N lower. High lane congestion predicted significant peak force increases of 4N and 7N in Sustained and Turning, respectively, but decreased by 20N in Initial. High precision control led to significant decreases in two-hand forces that ranged from 4 to 20N across motion phases. Complex interactions among the experimental factors suggest that work environment (lane congestion and floor surface) and work demands (precision control) should be included in the evaluation of pushing tasks and considered prior to making renovations to nursing home environments.

- **Keywords:** Ergonomic design; Carts; Manual handling; Healthcare

**In-Ju Kim, Hongwei Hsiao, Peter Simeonov. *Functional levels of floor surface roughness for the prevention of slips and falls: Clean-and-dry and soapsuds-covered wet surfaces.* Pages 58-64.**

Literature has shown a general trend that slip resistance performance improves with floor surface roughness. However, whether slip resistance properties are linearly correlated with surface topographies of the floors or what roughness levels are required for effective slip resistance performance still remain to be answered. This pilot study aimed to investigate slip resistance properties and identify functional levels of floor surface roughness for practical design applications in reducing the risk of slip and fall incidents. A theory model was proposed to characterize functional levels of surface roughness of floor surfaces by introducing a new concept of three distinctive zones. A series of dynamic friction tests were conducted using 3 shoes and 9 floor specimens under clean-and-dry as well as soapsuds-covered slippery wet environments. The results showed that all the tested floor–shoe combinations provided sufficient slip resistances performance under the clean-and-dry condition. A significant effect of floor type (surface roughness) on dynamic friction coefficient (DFC) was found in the soapsuds-covered wet condition. As compared to the surface roughness effects, the shoe-type effects were relatively small. Under the soapsuds-covered wet condition, floors with 50  $\mu\text{m}$  in  $R_a$  roughness scale seemed to represent an upper bound in the functional range of floor surface roughness for slip resistance because further increase of surface roughness provided no additional benefit. A lower bound of the functional range for slip resistance under the soapsuds-covered wet condition was estimated from the requirement of  $\text{DFC} > 0.4$  at  $R_a \approx 17 \mu\text{m}$ . Findings from this study may have potential safety implications in the floor surface design for reducing slip and fall hazards.

- **Keywords:** Floor surfaces; Roughness heights; Shoes; Slip resistance; Surface roughness

**Annie W.Y. Ng, Kin Wai Michael Siu, Chetwyn C.H. Chan. *Perspectives toward the stereotype production method for public symbol design: A case study of novice designers.* Pages 65-72.**

This study investigated the practices and attitudes of novice designers toward user involvement in public symbol design at the conceptual design stage, i.e. the stereotype production method. Differences between male and female novice designers were examined. Forty-eight novice designers (24 male, 24 female) were asked to design public symbol referents based on suggestions made by a group of users in a previous study and provide feedback with regard to the design process. The novice designers were receptive to the adoption of user suggestions in the conception of the design, but tended to modify the pictorial representations generated by the users to varying extents. It is also significant that the male and female novice designers appeared to emphasize different aspects of user suggestions, and the female novice designers were more positive toward

these suggestions than their male counterparts. The findings should aid the optimization of the stereotype production method for user-involved symbol design.

- **Keywords:** Public symbol design; Stereotype production method; Design practice

**Michelle M. Robertson, Vincent M. Ciriello, Angela M. Garabet. *Office ergonomics training and a sit-stand workstation: Effects on musculoskeletal and visual symptoms and performance of office workers.* Pages 73-85.**

Work Related Musculoskeletal Disorders (WMSDs) among office workers with intensive computer use is widespread and the prevalence of symptoms is growing. This randomized controlled trial investigated the effects of an office ergonomics training combined with a sit-stand workstation on musculoskeletal and visual discomfort, behaviors and performance. Participants performed a lab-based customer service job for 8 h per day, over 15 days and were assigned to: Ergonomics Trained ( $n = 11$ ) or Minimally Trained ( $n = 11$ ). The training consisted of: a 1.5-h interactive instruction, a sit/stand practice period, and ergonomic reminders. Ergonomics Trained participants experienced minimal musculoskeletal and visual discomfort across the 15 days, varied their postures, with significantly higher performance compared to the Minimally Trained group who had a significantly higher number of symptoms, suggesting that training plays a critical role. The ability to mitigate symptoms, change behaviors and enhance performance through training combined with a sit-stand workstation has implications for preventing discomforts in office workers.

- **Keywords:** Office ergonomics training; Musculoskeletal symptoms and performance

**Cristiane Shinohara Moriguchi, Letícia Carnaz, Kaj Bo Veiersted, Therese N. Hanvold, Liv Berit Hæg, Gert-Åke Hansson, Helenice Jane Cote Gil Coury. *Occupational posture exposure among construction electricians.* Pages 86-92.**

The aim of this study is to record, objectively describe and compare working postures of Brazilian and Norwegian construction electricians. Postures of the upper arms, head, and neck during work and breaks were quantified by means of inclinometry for a representative sample of 12 Brazilian and 12 Norwegian electricians in the construction industry during a full work-shift. Despite that differences were found between specific work-related factors, Brazilian and Norwegian workers revealed a high and very similar level and pattern of postures for all evaluated body regions, suggesting that results could be extrapolated to other electricians. Upper arm elevation was high and similar for both groups and head flexion and extension was pronounced compared to other occupations. Thus, extreme postures were identified for construction electricians in both countries, with similar exposure pattern also for defined tasks (planning, support and wiredraw), suggesting that this job is risky regardless organizational differences.

- **Keywords:** Overhead work; Inclinometry; Postural recording; Musculoskeletal disorders

**Jared Gragg, Jingzhou (James) Yang, Aimee Cloutier, Esteban Pena Pitarch. *Effect of human link length determination on posture reconstruction.* Pages 93-100.**

Motion capture experiment results are often used as a means of validation for digital human simulations. Motion capture results are marker positions and joint centers in Cartesian space. However, joint angles are more intuitive and easy to understand

compared to marker or joint center positions. Posture reconstruction algorithms are used to map Cartesian space to joint space by re-creating experimental postures with simulation models. This allows for direct comparison between the experimental results and digital human simulations. Besides the inherent experimental errors from motion capture system, one source of simulation error is the determination of the link lengths to be used in the simulation model. The link length errors can propagate through all simulation results. Therefore, it is critical to eliminate the link length errors. The objective of this study is to determine the best method of determining link lengths for the simulation model to best match the model to the experiment results containing errors. Specifically, the way that the link lengths are calculated in the posture reconstruction process from motion capture data has a significant effect on the recreated posture for the simulation model. Three link length calculation methods (experimental-average method, trial-specific method, and T-pose method) are developed and compared to a benchmark method (frame-specific method) for calculating link lengths. The results indicate that using the trial-specific method is the most accurate method when referring to calculating frame-specific link lengths.

- **Keywords:** Posture reconstruction; Link lengths; Digital human models; Motion capture

**Iman Dianat, Mohammad Ali Karimi, Ahmad Asl Hashemi, Samira Bahrampour. *Classroom furniture and anthropometric characteristics of Iranian high school students: Proposed dimensions based on anthropometric data.* Pages 101-108.**

The study evaluated the potential mismatch between classroom furniture dimensions and anthropometric characteristics of 978 Iranian high school students (498 girls, 480 boys), aged 15–18 years. Nine anthropometric measurements (stature, sitting height, sitting shoulder height, popliteal height, hip breadth, elbow–seat height, buttock–popliteal length, buttock–knee length and thigh clearance) and five dimensions from the existing classroom furniture were measured and then compared together (using match criterion equations) to identify any potential mismatch between them. The results indicated a considerable mismatch between body dimensions of the students and the existing classroom furniture, with seat height (60.9%), seat width (54.7%) and desktop height (51.7%) being the furniture dimensions with a higher level of mismatch. The levels of mismatch varied between the high-school grade levels and between genders, indicating their special requirements and possible problems. The proposed dimensions of the classroom furniture more appropriate for the students were given. This additional information on students' anthropometry can be used by local furniture industries as a starting point for designing more appropriate furniture for school children, or used by schools to aid in furniture selection.

- **Keywords:** Classroom furniture; Anthropometry; Mismatch

**Helen J. Burgess, Carlo S. Legasto, Louis F. Fogg, Mark R. Smith. *Can small shifts in circadian phase affect performance?* Pages 109-111.**

Small shifts in circadian timing occur frequently as a result of daylight saving time or later weekend sleep. These subtle shifts in circadian phase have been shown to influence subjective sleepiness, but it remains unclear if they can significantly affect performance. In a retrospective analysis we examined performance on the Psychomotor Vigilance Test before bedtime and after wake time in 11 healthy adults on fixed sleep schedules based on their habitual sleep times. The dim light melatonin onset, a marker of circadian timing, was measured on two occasions. An average 1.1 h shift away from a proposed optimal circadian phase angle (6 h between melatonin onset and midpoint of sleep) significantly slowed mean, median and fastest 10% reaction times before bedtime and

after wake time ( $p < 0.05$ ). These results add to previous reports that suggest that humans may be sensitive to commonly occurring small shifts in circadian timing.

- **Keywords:** Circadian; Melatonin; Performance

**Deirdre E. McGhee, Julie R. Steele, William J. Zealey, George J. Takacs. *Bra–breast forces generated in women with large breasts while standing and during treadmill running: Implications for sports bra design. Pages 112-118.***

This study aimed to determine the bra–breast forces generated in women with large breasts while these women wore different levels of breast support during both upright standing and treadmill running. The mean bilateral vertical component of the bra–breast force in standing was  $11.7 \pm 4.6$  N, whereas during treadmill running the mean unilateral bra–breast force was  $8.7 \pm 6.4$  N and  $14.7 \pm 10.3$  N in the high and low support conditions, respectively. Furthermore, breast mass was significantly correlated with vertical breast displacement ( $R^2 = 0.62$ ) in the high support condition. The wide range of breast masses of women with large breasts is an important consideration for designers of sports bras to ensure these bras can reduce force generation and breast discomfort by providing a high level of breast support while these women participate in physical activity.

- **Keywords:** Breast mass; Breast forces; Sport bra design

**Juergen Sauer, Peter Nickel, David Wastell. *Designing automation for complex work environments under different levels of stress. Pages 119-127.***

This article examines the effectiveness of different forms of static and adaptable automation under low- and high-stress conditions. Forty participants were randomly assigned to one of four experimental conditions, comparing three levels of static automation (low, medium and high) and one level of adaptable automation, with the environmental stressor (noise) being varied as a within-subjects variable. Participants were trained for 4 h on a simulation of a process control environment, called AutoCAMS, followed by a 2.5-h testing session. Measures of performance, psychophysiology and subjective reactions were taken. The results showed that operators preferred higher levels of automation under noise than under quiet conditions. A number of parameters indicated negative effects of noise exposure, such as performance impairments, physiological stress reactions and higher mental workload. It also emerged that adaptable automation provided advantages over low and intermediate static automation, with regard to mental workload, effort expenditure and diagnostic performance. The article concludes that for the design of automation a wider range of operational scenarios reflecting adverse as well as ideal working conditions needs to be considered.

- **Keywords:** Automation; Function allocation; Stress; Human performance

**Brianna Larsen, Tony Graham, Brad Aisbett. *A survey to identify physically demanding tasks performed during storm damage operations by Australian State Emergency Services personnel. Pages 128-133.***

Purpose

To identify and characterize the physically demanding tasks performed by SES personnel during storm damage work.

Methods

Thirty-six tasks identified as the most operationally important to storm damage work were included in a survey which was available to all SES volunteers. The survey aimed to

identify the physical demand, operational importance, frequency, duration, principal actions and fitness components of each task.

#### Results

Twelve tasks were identified as the most physically demanding. Of these, carrying sandbags, lifting sandbags and shoveling sand (with hands) rated highest. Covering roof damages with tarpaulin and erecting external weather proofing were ranked highest for operational importance. Box lifting (single-person) and erecting external weather proofing returned the highest mode values for frequency, whereas tasks involving handling sandbags returned the highest mean and median frequency values. Covering roof damages with tarpaulin was identified as the longest task. Bending, lifting, twisting and carrying were the most common actions identified for the physically demanding tasks. Muscular strength and muscular endurance were the primary fitness components identified for the twelve tasks.

#### Conclusion

SES personnel perform a variety of storm response tasks, many of which are physically demanding. All or most of the physically demanding tasks contain elements of bending, lifting, twisting and carrying, and call upon personnel's muscular strength and muscular endurance capabilities.

- **Keywords:** Operational importance; Emergency services

### **Hsin-Yi Kathy Cheng, Chen-Yi Cheng, Yan-Ying Ju. *Work-related musculoskeletal disorders and ergonomic risk factors in early intervention educators.* Pages 134-141.**

#### Background

Early intervention educators who serve children with special needs often suffer from physical strains. The objectives of this study were to investigate the prevalence of work-related musculoskeletal disorders in this population, and to evaluate the relationship between work-related musculoskeletal disorders and personal/ergonomic risk factors.

#### Methods

A self-designed questionnaire consisting three domains (demographics/prevalence of work-related musculoskeletal disorders/ergonomic risk factors) was delivered to educators who work in early intervention institutions.

#### Results

Ninety-four percent of early intervention educators suffered from musculoskeletal disorders. Logistic regression revealed that some work-related ergonomic factors were highly associated with symptoms on lower back, shoulder and neck, with odds ratios ranging from 0.321 to 4.256.

#### Conclusion

High prevalence of work-related musculoskeletal disorders impacts this occupation negatively. Further regulations to the institutions regarding workplace health promotion and environment modification, as well as training to the employees for body mechanics, should be implemented to prevent injury occurrence.

- **Keywords:** Musculoskeletal disorders; Ergonomic risk factors; Childcare workers

### **Lottie F.M. Kuijt-Evers, Reinier Könemann, M. Susan Hallbeck. *Effect of canopy shape on physical load when holding an umbrella.* Pages 142-150.**

The aim of the current study was to investigate the effect of the canopy shape of an umbrella on physical load when holding the umbrella in different circumstances. For this purpose, thirteen subjects participated in this study and muscle activity of seven muscles of the upper limb (including the forearm) was measured for 5 wind speeds (4, 5, 6, 7, 8 Bft) and two wind directions (front and side). From the results, it was seen that for the p50 value of the muscle activity, the umbrella with the asymmetric canopy required 62%

and for the p90 value of the muscle activity 74% of the muscle activity, on average, over all wind speeds – compared to the traditional umbrella. Based on these results, we can conclude that the physical load of holding the traditional umbrella is significantly higher than holding the umbrella with the asymmetric canopy shape in windy conditions.

- **Keywords:** Umbrella; Grip force; Upper limb; Muscle activity; %MVC; Physical load

**Monika Pölönen, Toni Järvenpää, Beatrice Bilcu. *Stereoscopic 3D entertainment and its effect on viewing comfort: Comparison of children and adults.* Pages 151-160.**

Children's and adults' viewing comfort during stereoscopic three-dimensional film viewing and computer game playing was studied. Certain mild changes in visual function, heterophoria and near point of accommodation values, as well as eyestrain and visually induced motion sickness levels were found when single setups were compared. The viewing system had an influence on viewing comfort, in particular for eyestrain levels, but no clear difference between two- and three-dimensional systems was found. Additionally, certain mild changes in visual functions and visually induced motion sickness levels between adults and children were found. In general, all of the system-task combinations caused mild eyestrain and possible changes in visual functions, but these changes in magnitude were small. According to subjective opinions that further support these measurements, using a stereoscopic three-dimensional system for up to 2 h was acceptable for most of the users regardless of their age.

- **Keywords:** Stereoscopic 3D; Children; Viewing comfort

**Ben-Tzion Karsh, Astrid C. Newenhouse, Larry J. Chapman. *Barriers to the adoption of ergonomic innovations to control musculoskeletal disorders and improve performance.* Pages 161-167.**

Despite a growing number of published articles describing studies of ergonomic interventions, little is known about the barriers potential adopters face when deciding whether or not to adopt such innovations. To this end, the purpose of this paper is to examine the barriers identified by potential adopters of ergonomic innovations and compare barriers identified by individuals not interested in adopting to those identified by individuals planning to adopt. Eight hundred forty-eight fresh market vegetable farmers were mailed surveys measuring the adoption of and barriers to the adoption of several ergonomic innovations as part of a multi-year intervention study. Barriers such as cost, lack of information, never having seen the innovation used and not being able to try out the innovation were among the barriers identified. The barriers identified were moderated by whether or not the respondents were likely to adopt. Implications for diffusing ergonomic and safety innovations are discussed.

- **Keywords:** Ergonomic interventions; Musculoskeletal disorders; Agriculture; Horticulture