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M. M. Blok; M. P. de Looze. *What is the evidence for less shift work tolerance in older workers?* Pages 221 – 232.

This paper explores the suggestion that older people would be less tolerant to shift work. Field studies on age-shift work interaction effects on sleep, fatigue, performance, accidents and health were reviewed. Studies on age-shift (morning, afternoon, night) and age-shift system (roster) interactions were also reviewed. In nine studies, shift and day workers were compared and interactions with age were addressed. Two studies reported more problems in older people, four studies reported opposite results, while in five studies no significant age-shift work interaction was observed. From across-shift comparisons (six studies), it was deduced that older compared with younger workers have more sleep problems with night shifts, while the opposite is true for morning shifts. This review did find some differences between older and younger workers, but did not find evidence for the suggestion of more shift work problems in older workers.

Statement of Relevance: This systematic review reveals the limited evidence that exists concerning shift work tolerance in older workers, highlighting an area for future research. Some interactions between age and shift type and shift system have been found, however. In view of these, it is argued that age-specific aspects should be considered in shift work planning.

- **Keywords:** ageing; health; performance; shift work; sleep

Ken W. L. Chan; Alan H. S. Chan. *Spatial stimulus response compatibility for a horizontal visual display with hand and foot controls.* Pages 233 – 245.

In this study, two experiments were conducted to examine spatial stimulus-response compatibility (SRC) effects for a horizontal visual display with hand and foot controls. In experiment 1, the hand and foot controls were in a hands above and feet below vertical plane, such that the display and controls were orthogonal to each other. In experiment 2, the foot pedals were moved forward and placed directly underneath the front row of signals, resulting in an additional horizontal display and control relationship. The results of experiment 1 revealed a strong orthogonal SRC effect, such that the best performance was for the front signals with hand controls and rear signals with foot pedals, which was not altered with the presence of horizontal location mappings in experiment 2. These findings indicate that the front-hand/rear-foot mapping relationship was quite robust with

regard to changes in the relative locations of the hand and foot response devices. **Statement of Relevance:** The results of this study provide useful ergonomics recommendations for designing control consoles with visual signals presented in a horizontal plane and control devices operated by hands and feet. They are helpful for improving efficiency and overall system performance in person-machine systems.

- **Keywords:** foot control; hand control; spatial compatibility; visual signal

A. Ranavolo; C. Conte; S. Iavicoli; M. Serrao; A. Silvetti; G. Sandrini; F. Pierelli; F. Draicchio. *Walking strategies of visually impaired people on trapezoidal- and sinusoidal-section tactile groundsurface indicators. Pages 246 – 256.*

The visual system in walking serves to perceive feedback or feed-forward signals. Therefore, visually impaired persons (VIP) have biased motor control mechanisms. The use of leading indicators (LIs) and long canes helps to improve their walking efficiency. The aims of this study were to compare the walking efficiency of VIP on trapezoidal- and sinusoidal-section LIs using an optoelectronic motion analysis system. VIP displayed a significantly longer stance phase, a shorter swing phase and shorter step and stride lengths when they walked on the sinusoidal LI than when they walked on the trapezoidal LI. Compared with the trapezoidal LI, VIP walking on the sinusoidal LI displayed significantly lower joint ranges of motion. The centre of mass lateral displacement was wider for VIP walking on the sinusoidal LI than on the trapezoidal LI. Some significant differences were also found in sighted persons walking on both LIs. In conclusion, the trapezoidal shape enabled visually impaired subjects to walk more efficiently, whereas the sinusoidal shape caused dynamic balance problems. **Statement of Relevance:** These findings suggest that VIP can walk more efficiently, with a lower risk of falls, on trapezoidal-section than on sinusoidal-section LIs. These results should be considered when choosing the most appropriate ground tactile surface indicators for widespread use.

- **Keywords:** gait analysis; tactile ground surface indicators; visually impaired people; walking efficiency

Fiona C. Trevelyan; Stephen J. Legg. *Risk factors associated with back pain in New Zealand school children. Pages 257 – 262.*

This study investigated risk factors associated with back pain in 245 New Zealand intermediate school children aged 11-14 years in a cross-sectional survey, using a self-completion questionnaire for demographic details, pain prevalence, psychosocial parameters, school and leisure activities and family characteristics. The strongest relationships were between back pain and common childhood complaints (stomach ache, headache and sore throats) ($p < 0.01$) and psychosocial factors (conduct and hyperactivity) ($p < 0.01$). For physical factors, there was a significant relationship between neck and low back pain and attributes of chairs. Low back pain was significantly related to low desk height (as reported by students) ($p < 0.05$). School bag weight was not significantly related to low back pain but carrying the bag on one shoulder was ($p < 0.05$). It is concluded that, amongst these intermediate school children, psychological, social and emotional factors had a stronger relationship with back pain than physical factors. **Statement of Relevance:** This study investigated risk factors associated with back pain amongst New Zealand intermediate school children. It showed that psychological, social and emotional factors may have a stronger relationship with back pain than physical factors.

- **Keywords:** children; musculoskeletal disorders; physical factors; psychosocial factors

Salam Rahmatalla; Jonathan DeShaw. *Predictive discomfort of non-neutral head-neck postures in fore-aft whole-body vibration. Pages 263 – 272.*

It seems obvious that human head-neck posture in whole-body vibration (WBV) contributes to discomfort and injury risk. While current mechanical measures such as transmissibility have shown good correlation with the subjective-reported discomfort, they showed difficulties in predicting discomfort for non-neutral postures. A new biomechanically based methodology is introduced in this work to predict discomfort due to non-neutral head-neck postures. Altogether, 10 seated subjects with four head-neck postures—neutral, head-up, head-down and head-to-side—were subjected to WBV in the fore-aft direction using discrete sinusoidal frequencies of 2, 3, 4, 5, 6, 7 and 8 Hz and their subjective responses were recorded using the Borg CR-10 scale. All vibrations were run at constant acceleration of 0.8 m/s² and 1.15 m/s². The results have shown that the subjective-reported discomfort increases with head-down and decreases with head-up and head-to-side postures. The proposed predictive discomfort has closely followed the reported discomfort measures for all postures and rides under investigation. **Statement of Relevance:** Many occupational studies have shown strong relevance between non-neutral postures, discomfort and injury risk in WBV. With advances in computer human modelling, the proposed predictive discomfort may provide efficient ways for developing reliable biodynamic models. It may also be used to assess discomfort and modify designs inside moving vehicles.

- **Keywords:** neck posture; predictive discomfort; reported discomfort; transmissibility; whole-body vibration

Hiroshi Endo; Koichi Kawahara. *Gender differences in hand stability of normal young people assessed at low force levels. Pages 273 – 281.*

To examine gender differences in hand stability, finger position and force holding tasks at low force levels were conducted with 30 male and 30 female young adults. Total fluctuation was defined as the standard deviation of measured data and fluctuation and the 10-Hz component of the physiological tremor were compared between male and female subjects. In all tasks, the total fluctuation and the 10-Hz tremor were significantly larger in male subjects than females. On average, the fluctuation was 1.3 times larger and the 10-Hz tremor was 1.6 times larger. The results of this study suggest that women have superior hand stability compared with men at low force levels. Finger length, maximal voluntary contraction and surface electromyography were also measured and factors related to gender differences in hand stability are discussed. **Statement of Relevance:** Hand stability is crucial for precise manual operations. This study demonstrated gender differences in hand steadiness at low force levels. Though hand dexterity cannot be explained only by hand stability, the results of this study are useful not only for occupational aptitude tests but also for neuropsychological tests.

- **Keywords:** force fluctuation; gender differences; hand stability; low contraction intensity; physiological tremor

Shuping Xiong; Ravindra S. Goonetilleke; Zuhua Jiang. *Pressure thresholds of the human foot : measurement reliability and effects of stimulus characteristics. Pages 282 – 293.*

Information related to reliable values of discomfort thresholds can help to improve the designs of various products. This study aimed to investigate the measurement reliabilities associated with pressure thresholds, while determining the effects of stimulus characteristics (stimulus area, indentation speed) of the human foot. An indentation apparatus was used with four sizes of indentation probes and three indentation speeds.

In total, 13 locations on the right foot of 10 male and 10 female participants were tested to determine the pressure discomfort thresholds (PDT) and pressure pain thresholds (PPT). Results show that the tests had very good measurement reliability with intra-class correlations (ICC) greater than 0.8 for the PPT measurements and acceptable reliability (most ICC > 0.75, with a few between 0.5 and 0.75) for the PDT measurements, demonstrating that participants are capable of judging their pain and discomfort thresholds. Pressure sensitivity differs across locations of the foot, with the medial plantar arch of the foot being the most sensitive, followed by the dorsal surface of the foot. The heel area was the least sensitive. PPT and PDT are dependent on the stimulus characteristics of the area and the speed of indentation. A smaller area has a higher PPT and PDT, indicating significant effects of spatial summation. The increase of PDT and PPT at higher speeds may be partially explained by the increase in stiffness because foot tissue exhibits viscoelastic properties. The findings can have a significant impact on the design of footwear and other accessories for improved foot health and comfort.

Statement of Relevance: This study investigated the threshold measurement reliability while determining the pressure sensitivity on the surface of the foot with varying stimulus characteristics. The findings may be very useful in the design of footwear and other accessories for improved comfort and reduced injuries.

- **Keywords:** arch; design; discomfort; foot; foot sensitivity; footwear; ICC; indentation; measurement reliability; pain; PPT; pressure thresholds; spatial summation

I. Krauss; C. Langbein; T. Horstmann; S. Grau. *Sex-related differences in foot shape of adult Caucasians : a follow-up study focusing on long and short feet.* Pages 294 – 300.

The study's purpose was to substantiate findings on sex-related differences in foot morphology focusing on fringe sizes. Altogether, 287 Caucasian adults with long or short feet were scanned. Data were analysed together with data from 847 subjects from a previous study with comparable inclusion criteria and anthropometric data by: (1) comparing absolute measures within 237-277 mm foot length (FL); (2) comparing averaged measures across sizes in % of foot length for 203-323mm FL; (3) reclassifying the additional subjects into a previously defined foot type classification. Male feet were wider and higher for the same FL. Averaged across sizes, no relevant differences between sexes were found for widths and heights. Slender or flat-pointed foot types were more common in longer feet, shorter feet tended to be bigger. Definitions for 'long' and 'short' are sex-related with an offset of three shoe sizes (EU). Results of this follow-up study on long and short feet can substantiate previous findings mainly described for the most common sizes. **Statement of Relevance:** Improper footwear can cause pain and injury and proper fit is a major criterion for shoe buyers. Knowledge about sex-related differences in foot shape is important for shoe design. This study supplements the field of knowledge for very small and large feet.

- **Keywords:** anthropometry; cluster analysis; foot dimensions; footwear; sex-related differences

Y. S. Wu; J. T. Fan; W. Yu. *Effect of posture positions on the evaporative resistance and thermal insulation of clothing.* Pages 301 – 313.

Evaporative resistance and thermal insulation of clothing are important parameters in the design and engineering of thermal environments and functional clothing. Past work on the measurement of evaporative resistance of clothing was, however, limited to the standing posture with or without body motion. Information on the evaporative resistance of clothing when the wearer is in a sedentary or supine posture and how it is related to that when the wearer is in a standing posture is lacking. This paper presents original data on the effect of postures on the evaporative resistance of clothing, thermal insulation and

permeability index, based on the measurements under three postures, viz. standing, sedentary and supine, using the sweating fabric manikin-Walter. Regression models are also established to relate the evaporative resistance and thermal insulation of clothing under sedentary and supine postures to those under the standing posture. The study further shows that the apparent evaporated resistances of standing and sedentary postures measured in the non-isothermal condition are much lower than those in the isothermal condition. The apparent evaporative resistances measured using the mass loss method are generally lower than those measured using the heat loss method due to moisture absorption or condensation within clothing. **Statement of Relevance:** The thermal insulation and evaporative resistance values of clothing ensembles under different postures are essential data for the ergonomics design of thermal environments (e.g. indoors or a vehicle's interior environment) and functional clothing. They are also necessary for the prediction of thermal comfort or duration of exposure in different environmental conditions.

- **Keywords:** evaporative resistance; moisture permeability index; sedentary posture; supine posture; sweating fabric manikin; thermal comfort; thermal insulation