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HUMAN RESPONSE TO VIBRATION

ABSTRACTS

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H. Langauer-Lewowicka, B. Harazin, I. Brzozowska and P. Szlapa 1996 *Medycyna Pracy* **47**(2), 97–106. Ocena ryzyka zdrowotnego operatorow pojazdow i maszyn robocych narazonych na dzialanie ogolnych drgan mechanicznych. Evaluation of health risk in machine operators exposed to the whole-body vibration. (10 pages, 4 figures, 5 tables, 17 references) (in Polish).

English Summary. A total of 45 machine operators employed at the same power station were examined with special emphasis put on the musculoskeletal system. A group of 15 bulldozer operators, 19 engine operators and 11 tractor drivers were exposed to whole-body vibration with average vertical equivalent acceleration ranging from 0·2 m s^{-2} to 0·5 m s^{-2} r.m.s. The incidence of low back complaints over a period of 12 months was similar to that observed in the occupational study groups. However, back pains combined with other health disorders were most common in bulldozer operators (80%), while the lowest percentage (36%) of such cases was observed among tractor drivers. The analysis of lifetime exposure to whole-body vibration in both groups showed that bulldozer operators worked only 5 years longer, on average, but they spent twice as many hours at work as tractor drivers. The study indicates that individual lifetime exposure to whole-body vibration may play an important part in the evaluation of health effects.

Topics: Injury and Disease (whole-body); Vibration measurements (off-road vehicles).

J. Malchaire, A. Piette and I. Mullier 1996 *Annals of Occupational Hygiene* **40**(1), 79–91. Vibration exposure on fork-lift trucks. (13 pages, 4 figures, 5 tables, 7 references) (in English).

Authors' Abstract. This study investigates the effects of the main characteristics of the working conditions on the vibration exposure of fork-lift trucks. Four hundred and eighty recordings were made on five trucks equipped with four different types of tyres and a "normal" or an "anti-vibration" seat driven while empty or loaded, on a smooth or a rough track, by three workers. An analysis of variance was performed to study the main effects and the significant interactions between these factors. A mathematical model is proposed for the weighted acceleration on the floor and on the seat in the vertical axis. This shows quantitatively that the vibration exposure is mainly influenced by the roughness of the track, the speed, and the quality of the seat. Inflated tyres are preferable when an anti-vibration seat with a very low resonance frequency is used. In other cases, cushion tyres are more indicated.

Topics: Vibration measurements (off road vehicles); Seating (suspension seats).

P. G. Bedewi and N. E. Bedewi 1996 *International Journal of Crashworthiness* **1**(1), 50–72. Modelling the occupant biomechanics with emphasis on the analysis of lower extremity injuries. (23 pages, 8 figures, 5 tables, 50 references) (in English).

Authors' Abstract. This paper addresses the use of the finite element method to the simulation of humans in an impact environment. An extensive literature survey reveals

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several rigid body dynamics models of the human and sub-components: however, relatively little work has been performed using finite elements. Difficulties remain in characterizing the material properties of the associated biological materials because of non-linear, inhomogeneous, anisotropic and rate dependent behaviour. Physical testing using cadavers remains the primary means for determining human impact response and for validating the models created. A method for creating human finite element models is presented which requires the model to be developed in a ground-up approach and in a component-wise manner. Each component has five levels of detail, with level one being a collection of rigid segments connected by simple joints and level five consisting of a highly detailed model with proper material properties and injury mechanisms included. This method has been employed to create a level two human extremity model. The model consists of accurate geometric segments of the individual bones on the leg. Each segment is connected using joint definitions in LS-DYNA3D that contain the non-linear stiffness characteristics of the hip, knee and ankle. The model was used to simulate the loading conditions of a 50% overlap collision of two mid-sized cars with a closing speed of 112 km/hr (70 mph). A parametric study to determine the effects of muscle tensioning was performed for 27 different joint loading cases. Results indicated that muscle tensioning greatly affected the kinematics of the leg during high speed impact events. Greater stiffness in the hip and knee directly results in a higher potential for injury in the ankle. In addition higher levels of muscle activation in the ankle reduced injuries from the deceleration pulse of the impact, however, toepan intrusion still presented potential harm to the ankle.
Topics: Biodynamics (impact response; models).

R. Kaji, J. C. Rothwell, M. Katayama, T. Ikeda, T. Kubori, N. Kohara, T. Mezaki, H. Shibasaki and J. Kimura 1995 *Annals of Neurology* **38**, 155–162. Tonic vibration reflex and muscle afferent block in writer's cramp. (8 pages, 5 figures, 1 table, 29 references) (in English).
Authors' Abstract. Patients with focal dystonia take advantage of certain cutaneous or proprioceptive sensory inputs to alleviate their symptoms ('sensory trick'). We examined the effects of increasing muscle spindle activity by the tonic vibration reflex manoeuvre and decreasing it by intramuscular injection of lidacaine. The vibration was applied to the palm or the tendon of forearm muscles in 15 patients with writer's cramp and 15 age-matched normal subjects. In 11 patients, the vibration induced dystonic postures or movements typical of those seen during writing. Normal subjects showed either no response to the vibration or a gradually developing tonic vibration reflex only in the wrist and finger flexors, which produced visible movements with a significantly longer latency ($12{\cdot}5 \pm 6{\cdot}7$ s {mean $\pm$ standard deviation}) than what was observed in the patients ($2{\cdot}7 \pm 2{\cdot}5$ s, $p < 0{\cdot}0001$). Local injection of lidocaine (0·5%, 5–40 ml/muscle) attenuated the tendon reflex with relatively little effect on the M response. Injection into muscles with increased activity produced marked reduction of dystonic movements and significant clinical improvement in 13 patients, whereas injection into the other muscles had no effect. The clinical benefit lasted for 1 to 24 hours after injection. In 13 patients who had additional injections of 10% ethanol, which blocks sodium channels for a longer period than does lidocaine, the duration of action was prolonged to 5 to 21 days. These findings suggest that muscles causing dystonic movements have abnormal sensitivities to vibration at rest and that muscle afferents may play a pivotal role in producing dystonic movements. Local injection of lidocaine or ethanol reduces the effectiveness of muscle spindle afferent and may provide a means of treating patients with writer's cramp without causing unwanted weakness.
Topics: Perceptual mechanisms (proprioception); Physiological effects (muscle and nerve).

S. Mori 1995 *Nagoya Journal of Medical Science* **58**, 71–81. Disorientation of animals in microgravity. (11 pages, 4 figures, 0 tables, 32 references) (in English).
Author's Abstract. Disorientation responses of animals exposed to microgravity produced by parabolic aircraft flights and also in-space experiments were reviewed. Disoriented postures in floating are largely species-dependent. Reflexive lowered tone of gravity-bearing extensor muscles by labyrinthectomy is not seen in mammals (hamster and monkey) and frog, though dorsiflexion of the neck and the trunk is not so remarkable in hamster and monkey as in frog. In weightlessness, fundamental vestibular reflexes may be affected (righting reflex in cat), but coordinated performance can be easily compensated by visual function (mouse, monkey and turtle). In normal birds and fish who can move three-dimensionally in their environments, exposure to parabolic flight microgravity induces irregular tumbling with the eyes open and regular looping with the eyes closed, although the loop direction is the opposite in these two animals; backward (inside) in pigeon and forward (outside) in fish. Most recently, however, it was found that normal fish (goldfish) tumbled backward when observed in prolonged microgravity in space, suggesting that microgravity effects on fish in aircraft-flight parabols would differ from those in space. Sensory conflicts in normal fish diminish remarkably during 3–4 days of space microgravity, and the cerebellum may be involved in the recovery, lending support to the sensory conflict theory for the genesis of space motion sickness.
Topics: Physiological effects (postural function); Perceptual mechanisms (vestibular).

T. G. Dobie and J. G. May 1995 *British Journal of Clinical Psychology* **34**, 301–311. The effectiveness of a motion sickness counselling programme. (11 pages, 2 figures, 0 tables, 10 references) (in English).
Authors' Abstract. Unselected volunteers were offered a course of instruction in using the cognitive-behavioural approach to helping individuals tolerate the deleterious effects of different motion environments. In order to evaluate the programme, 11 of the participants volunteered to counsel independently individuals who were prone to motion sickness, using cognitive–behavioural training which included reinforcement by visually induced apparent motion. The subjects were pre- and post-tested by an independent observer using tolerance and motion response as the dependent variables. These test scores were compared to previous data obtained with subjects who had received counselling from an experienced counsellor, or had received no such counselling. The results indicated that the newly trained counsellors' subjects showed significant pre- and post-test tolerance to the motion stimulus, although they did not benefit as much as subjects trained by the experienced counsellors. However, in terms of post-test symptomatology and magnitude estimates of motion sickness, the trainees' subjects exhibited as much benefit as did those of the experienced counsellor. These data are taken as strong support for the feasibility of training counsellors to employ this method of alleviating motion sickness.
Topics: Motion sickness (prevention).

M. J. Griffin 1997 *Occupational and Environmental Medicine* **54**(2), 73–89. Measurement, evaluation, and assessment of occupational exposures to hand-transmitted vibration. (14 pages, 11 figures, 4 tables, 36 references) (in English).
Author's Abstract. The measurement of hand-transmitted vibration converts oscillatory movements to a form in which they can be evaluated with respect to human responses and assessed for their acceptability. This paper presents methods of measurement, evaluation, and assessment currently advocated in standards and other forms of guidance. The degree to which the methods of evaluating different frequencies, directions, and durations of vibration affect the assessment of vibration on different tools is illustrated. With the

frequency weighting currently used to allow for the effects of different frequencies there is little need to measure vibration at frequencies as high as 1000 Hz; this has significant implications to the design and evaluation of proposed antivibration devices, including gloves. Without the current frequency weighting, vibration at frequencies greater than 250 Hz can contribute to the magnitude of the vibration, but many common causes of injury from hand-transmitted vibration have their dominant components of vibration below 250 Hz. On many powered tools, although the dominant frequency of vibration is the same before and after frequency weighting, the reported magnitude of vibration is greatly affected by the frequency weighting. On tools with dominant low frequencies, their vibration is rated as being of far greater importance relative to other tools when considering frequency-weighted acceleration than when considering unweighted acceleration. It is shown that the effect of considering three axes of vibration as opposed to one axis has a greater effect on some tools than on others. The uncertainties and assumptions involved in the measurement evaluation, and assessment of hand-transmitted vibration are reviewed. It is suggested that whereas current decisions on health and welfare should be based on current assessment methods, the measurement and evaluation of hand-transmitted vibration should involve the collection and reporting of data which allow other interpretations in the future.
Topics: Vibration syndrome (general); Standardisation; Criteria and Limits.

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*Contributions to the Literature Collection are invited. They should be sent to Professor M. J. Griffin, Human Factors Research Unit, Institute of Sound and Vibration Research, University of Southampton, Southampton, SO*17 1*BJ, England.*