Journal of Sound and Vibration (2001) **242**(5), 939–942
doi:10.1006/jsvi.2001.3441, available online at http://www.idealibrary.com on IDEAL®

HUMAN RESPONSE TO VIBRATION

ABSTRACTS

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T. Videman, R. Simonen, J.-P. Usenius, K. Österman and M. C. Battié 2000 *Clinical Biomechanics* **15**, 83–86. The long-term effects of rally driving on spinal pathology. (4 pages, 1 figure, 2 tables, 9 references) (in English).

Authors' Abstract. Objectives—To investigate the consequences of rally driving on lumbar degenerative changes. Background—Vehicular driving is suspected to accelerate disc degeneration through whole-body vibration, leading to back problems. However, in an earlier well-controlled study of lumbar MRI findings in monozygotic twins, significant effects of lifetime driving on disc degeneration were not demonstrated. Another study of machine operators found only long-term exposure to vibration on unsprung seats led to a reduction in disc height. Design—Case-control study comparing rally drivers with population sample. Methods—Eighteen top rally and co-drivers, mean 43 years (SD, 10), volunteered for the study. The subjects were interviewed and imaged with a MR scanning and lumbar images were analyzed for degenerative findings using a standard scoring protocol previously published. The reference group was composed of 14 men, mean age 55 years (SD, 10), selected from a population sample. Results—Overall results showed no significant differences in lumbar degenerative findings as assessed from MR images between the rally drivers and the reference group; age-adjusted differences were not statistically significant for disc heights, bulges, herniations, end-plate irregularities, or osteophytes. Conclusions—Even extreme vehicular vibration as experienced in rally driving does not appear to have significant effects on disc generation. Relevance—The study does not support driving, and its associated whole-body vibration, as a significant cause of disc degeneration and question the theory that the higher incidence of back pain among drivers is due to accelerated disc degeneration. Other driving-related factors, such as postural stress, may deserve more attention.

Topics: Injury and disease; Physiological effects (skeletal).

S. Lings, and C. Leboeuf-Yde 2000 *International Archives of Occupational and Environmental Health*, **73**, 290–297. Whole-body vibration and low back pain: a systematic critical review of the epidemiological literature 1992–1999. (8 pages, 0 figures, 2 tables, 28 references) (in English).

Authors' Abstract. Objectives—A previous extensive review of the literature including that from the middle of 1992 concluded that whole-body vibrations may contribute to low back pain, but that the exposure–response relationship had not been clarified. We reviewed the literature of the past 7 years to find out: (i) whether there is evidence in the recent

0022-460X/01/200939 + 04 $35.00/0

epidemiological literature for causal association between whole-body vibrations and low back pain, and (ii) if there is evidence in the recent literature for a dose–response relationship between whole-body vibrations and low back pain. Methods—All relevant epidemiological articles which were obtained through a search in the databases, MEDLINE, OSH-ROM and TOXLINE, and through personal communication, were reviewed independently by the two authors, using a checklist. Results—Twenty-four original articles concerning the association between whole-body vibrations and the lower back were retained for use. The quality of the papers was mostly low, but improved with time. Only seven articles passed our predetermined quality criteria. Of the seven reports, one showed increased frequency of lumbar prolapse in occupational drivers, and six showed low back pain to be more frequent in whole-body-vibration-exposed groups. Only two out of the four articles reporting on dose, showed a dose-response association. Conclusions—Despite the lack of definite evidence, we found sufficient reasons for the reduction of whole-body-vibration-exposure to the lowest possible level. If new knowledge is to be produced, good prospective studies with repeated measurements of exposure, analyses of work postures, and clear definitions and subgroupings of low back pain are needed. Other research in this field should be given up, and the resources used for more important issues, as the size of the problem of whole-body vibration is probably on the decrease because of the technical prophylactic developments that are already in progress. *Topics*: Injury and disease; Phsiological effects (skeletal).

H.-Y. Chuang, J. Schwartz, S.-Y. Tsai, M.-L. T. Lee, J.-D. Wang and H. Hu 2000 *Occupational and Environmental Medicine*, **57**, 588–594. Vibration perception thresholds in workers with long term exposure to lead. 6 pages, 2 figures, 5 tables, 36 references) (in English).

Authors' Abstract. Objectives—To evaluate the impact of long-term exposure to lead on function of the peripheral nervous system as reflected by vibration perception threshold (VPT), measured with a portable vibrameter. Methods—Two hundred and seventeen workers in a lead battery factory were required to have an annual blood lead measurement during each of the 5 years preceding this study. All were invited to take the VPT test. A total of 206 workers were studied. The associations were analyzed between VPTs and current blood lead concentration, mean concentration of blood lead over the past 5 years, maximum blood lead concentration during the past 5 years, index of cumulative blood lead (ICL), time-weighted index of cumulative blood lead (TWICL), and percentage of lifespan spent at work in the plant, as well as the other potential confounders. Ordinary multiple regressions, generalized additive models, and hockey stick regression analyses were used to explore the potential existence of a threshold effect of blood lead variables on VPT. Results—VPT at a frequency of 220 Hz ranged from 6 to 100 (10^{-2} g, or 0·098 m/s^2) with a mean (SD) of 19·8 (14·2) for the feet and from 4 to 43 with a mean (SD) or 10·2 (6·1) for the hands. The five variables of exposure to lead were all significantly correlated with VPT of the feet but not the hands. In multiple linear regression analyses, the mean of the blood lead concentrations and the TWICL were significantly associated with VPT of the feet. The relation between VPT of the feet and mean blood lead was shown to be a J shaped curve with a generalized additive model and local smoothing technique. In the hockey stick regression, evidence was found of a threshold effect at a mean blood lead concentration of 31 μg/dl. Above this threshold it was estimated that each increase of 1 μg/dl mean blood lead over 5 years would increase VPT of the feet by 0·29 (10^{-2} g) or 0·28 m/s^2 (at a frequency of 220 Hz) with other potential confounders held constant. Conclusions—This study suggests that measurement of vibration sensory threshold is a relatively effective tool for detecting lead neuropathy in field studies, and that lead might cause sensory neuropathy

with an effect threshold corresponding to a 5 year mean blood lead concentration of 31 μg/dl.
Topics: Vibration sense (diagnosis).

M. S. Laskar and N. Harada 1999 *International Archives of Occupational and Environmental Health*, **72**, 462–468. Assessment of autonomic nervous activity in hand-arm vibration syndrome patients using time- and frequency-domain analyses of heart rate variation. (7 pages, 1 figure, 6 tables, 36 references) (in English).
Authors' Abstract. Objectives—The aim of the present study was to non-invasively assess autonomic nervous activity, using time- and frequency-domain analyses of heart rate variation (HRV), and to investigate the relationship between indices of HRV and duration of exposure to vibration (DEV), time since retirement from work involving vibration (TR) and time undergoing treatment (TT) in a group of patients with hand-arm vibration syndrome (HAVS). Subjects and methods—Twenty one HAVS patients who were no longer exposed to vibration and were undergoing standard treatment for HAVS, and 10 healthy control subjects, similar to the patients in age, height, weight and number of current smokers and drinkers, volunteered for this study. Indices of HRV [time-domain indices (the mean of R–R intervals, standard deviation and coefficient of variation) and normalized units of frequency-domain indices [low-frequency (LF) and high-frequency (HF) components], indicating parasympathetic nervous activity, were calculated from 2 min electrocardiographic data recorded during spontaneous breathing by subjects in supine rest. Results—The LF and HF components of the patients were significantly lower than those of the healthy controls ($P < 0{\cdot}05$). When Pearson correlation analysis was applied for the patient group, using indices of HVR with age, weight, height, DEV, TR and TT, the LF components positively related to TR and TT ($P < 0{\cdot}01$). The patients were thus divided into three groups as follows, according to TR: group A (1 year), group B ($> 1- < 5$ years) and group C (5–10 years), or according to TT: group X (1 year), group Y ($> 1- < 5$ years) and group Z (5–10 years). The LF components of the groups A and X were significantly lower than that of the healthy controls ($P < 0{\cdot}01$). The HF components of the groups A and X were also significantly lower than that of the healthy controls ($P < 0{\cdot}05$). Conclusions—The findings of the present study indicate decreased cardiac parasympathetic activity in the HAVS patients in comparison to the healthy controls. The TT and TR significantly influenced the HRV results in these patients; however, the DEV did not. The findings also indicate that treatment and cessation of exposure to vibration might have a beneficial effect on the cardiac parasympathetic activity in HAVS patients.
Topics: Vibration syndrome (general); Physiological effects (cardiovascular).

H. Suzuki, H. Shiroto, A. Tanaka, K. Tezuka and H. Takai 2000 *Quarterly Report of the Railway Technical Research Institute*, **41**, 106–111. Psycophysical evaluation of railway vibrational discomfort on curved sections. (6 pages, 6 figures, 1 table, 6 references) (in English).
Authors' Abstract. A series of experiments for evaluating the railway riding comfort on curved sections were carried out with subjects riding on trains or mock-up vehicles. In this paper, we propose a riding comfort index on curved sections, which uses stationary lateral acceleration jointly with peak-to-peak lateral acceleration and show acceptable values of discomfort. This paper also proposes an index for evaluating the riding comfort of a tilting train passing transition curves, to which roll motion is added. In addition, we make it possible to quantitatively express the relationship between the discomfort of passengers and the tilt angle of the floor when a train stops on a canted curve.
Topics: Ride (rail vehicles); Subjective assessment (general).

M. Tumer, M. J. Griffin and I. Holland 2000 *Aviation, Space, and Environmental Medicine*, **71**, 1181–1189. Airsickness and aircraft motion during short-haul flights. (9 pages, 7 figures, 3 tables, 25 references) (in English).
Authors' Abstract. Background—There is little quantitative information that can be used to predict the incidence of airsickness from the motions experienced in military or civil aviation. This study examines the relationship between low-frequency aircraft motion and passenger sickness in short-haul turboprop flights within the United Kingdom. Methods—A questionnaire survey of 923 fare-paying passengers was conducted on 38 commercial airline flights. Concurrent measurements of aircraft motion were made on all journeys, yielding approximately 30 h of aircraft motion data. Results—Overall, 0·5% of passengers reported vomiting, 8·4% reported nausea (range 0–34·8%) and 16·2% reported illness (range 0–47·8%) during flight. Positive correlations were found between the percentage of passengers who experienced nausea or felt ill and the magnitude of low-frequency lateral and vertical motion, although neither motion uniquely predicted airsickness. The incidence of motion sickness also varied with passenger age, gender, food consumption and actively during air travel. No differences in sickness were found between passengers located in different seating sections of the aircraft, or as a function of moderate levels of alcohol consumption. Conclusions—The passenger responses suggest that a useful prediction of airsickness can be obtained from magnitudes of low-frequency aircraft motion. However, some variations in airsickness may also be explained by individual differences between passengers and their psychological perception of flying.
Topics: Ride (aircarft); Motion sickness.

N. Toibana, H. Sakakibara, M. Hirata, T. Kondo and H. Toyoshima 2000 *Industrial Health*, **38**, 366–371. Thermal perception threshold testing for the evaluation of small sensory nerve fiber injury in patients with hand-arm vibration syndrome. (6 pages, 0 figure, 4 tables, 22 references) (in English).
Authors' Abstract. The aim of the present study was to investigate whether thermal perception threshold testing is a useful method that could replace pain thresholds testing in the evaluation of small sensory nerve fiber injury in vibration-induced neuropathy. Vibration, pain, and thermal (warm and cold) perception thresholds were examined on both middle fingers of 50 patients with hand-arm vibration syndrome and 29 healthy controls of similar age. The patients were divided into three subgroups according to the Stockholm Workshop sensorineural scale. Thermal (warm and cool) thresholds as well as vibration and pain thresholds were significantly more deteriorated among the patients than in the controls. Among the patients, warm thresholds elevated and cold thresholds lowered according to the Stockholm Workshop scale. Thermal thresholds were significantly correlated with pain thresholds, and the sensitivity of the thermal threshold testing tended to be greater than that of the pain threshold testing. The present findings indicate that thermal threshold testing for warm and cold perception can be useful substitute for pain threshold testing to examine small nerve fiber injury in vibration-induced neuropathy.
Topics: Hand-arm vibration syndrome (sensori-neural).

NOTE: Copies of all papers in this section will be found in the Human Response to Vibration Literature Collection at the Institute of Sound and Vibration Research, University of Southampton. The papers may be used by persons visiting the Institute.

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