1. Project Identification — NOT CONFIDENTIAL

Risks of Occupational Vibration Exposures

(VIBRISKS)

Contract N°	QLK4-2002-02650	**Project type**	Shared Costs
Project duration	48 months	**Commencement date**	1st January 2003
Total project cost	€ 1,642,836	**EC contribution**	€ 1,591,826

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2. Project Summary NOT CONFIDENTIAL

Background

Millions of European workers are exposed to mechanical vibration transmitted to their hands from powered tools or transmitted to their whole body from the seats of industrial vehicles. Disorders of the upper limbs caused by hand-transmitted vibration are among the most compensated industrial diseases in several European states and exposure to whole-body vibration is associated with disorders of the spinal system.

The currently standardised methods of assessing the severity of vibration exposures are not based primarily on epidemiological evidence or on an understanding of the relevant mechanisms of injury. They are not sufficient to predict the risks of injury or define optimum means of preventing injury.

Objectives

The principal objective of VIBRISKS was to improve understanding of the risks of injury from exposures to hand-transmitted vibration and whole-body vibration at work by means of multi-national epidemiological studies, supported by fundamental laboratory research and biodynamic modelling.

Secondary objectives were: (i) to contribute to a scientific basis for political decisions on the adequacy of current preventive measures and expenditure on prevention; (ii) to provide guidance on health surveillance that can be applied by occupational health workers across Europe for the minimisation of risk (primary prevention), the screening of exposed workers, and the management of individuals who have symptoms of hand-transmitted vibration injuries (secondary prevention); and (iii) to help industry by reducing the social and economic costs associated with disorders.

Work Programme

The studies of hand-transmitted vibration (HTV) and whole-body vibration (WBV) developed some common tools and procedures. For both HTV and WBV, the work was divided into three components:

Coordinated multi-national epidemiological field studies of dose-response relationships for adverse outcomes arising from occupational exposures to vibration.

Laboratory experimental studies and biodynamic modelling to support the field investigations, including the definition of alternative means of evaluating vibration exposures and predicting risk.

Supporting activities, including: (i) the definition of methods to be used in the epidemiological surveys, and (ii) the integration of the findings from the experimental and biodynamic studies with the results of the epidemiological research so as to provide occupational health guidance.

Results and Achievements

Epidemiological studies

In Italy and Sweden, baseline and follow-up longitudinal epidemiological studies were completed with groups of workers having different exposures to hand-transmitted vibration. A second follow-up survey was completed in Italy. The Italian survey provided evidence of dose-response relationships for sensorineural and vascular symptoms and a dose-effect relationship for cold-induced digital arterial hyper-responsiveness and impaired manual dexterity in HTV-exposed workers. The Swedish study group had only short vibration exposures, but significant associations were found between indices of peripheral vascular and sensory dysfunction and measures of daily and cumulative vibration dose. Vibration exposure and awkward neck postures were associated with neck pain among the workers.

In Italy, Sweden, the Netherlands and the UK, baseline and follow-up longitudinal epidemiological surveys were completed with groups of workers occupationally exposed to whole-body vibration. A further follow-up survey was completed in Italy and an intervention study in the Netherlands continues to investigate the effects of health surveillance and other intervention measures. Various physical and psychosocial factors were found to be associated with an increased risk of low back pain (LBP). The Italian and the Dutch results were consistent with increased risk of LBP in those with higher cumulative exposures to whole-body vibration. However, standardised measures of daily vibration exposure were poorly associated with LBP. Studies in Sweden and the UK did not find clear relationships between WBV and LBP. The findings of a case-control study in the UK suggest that, in the general population, WBV is not an important cause of LBP that is severe enough to result in referral for MRI imaging of the lumbar spine.

Experimental and modelling studies

Collaborative experimental studies were carried out in Italy, Sweden, and the UK to improve understanding of the effects of vibration magnitude, frequency and duration on acute changes in both vascular function (finger blood flow and finger systolic blood pressure) and neurological function (vibration

perception thresholds and thermotactile thresholds). The observed changes in vascular and sensorineural function during and following vibration exposure were not consistent with the 'energy-equivalent' time-dependency currently used to evaluate occupational exposures to hand-transmitted vibration. The vascular studies suggest that intermittent vibration is less hazardous than continuous vibration with the same 'energy'. Reductions in finger blood flow were not limited to the finger experiencing force and vibration. Both vibration magnitude and exposure duration influenced thermotactile thresholds.

Collaborative experimental studies by Italy and the UK suggested that recent exposure to force and moderate levels of hand-transmitted vibration will not greatly affect finger systolic blood pressure following cold provocation, as used to identify vibration-induced white finger. In Sweden, prior exposure to vibration on the day of a test was found to influence vibrotactile and thermotactile perception thresholds.

In the UK, studies of the effects of age and gender on vascular function (finger systolic blood pressure after cooling) and sensory function (thermotactile and vibrotactile thresholds) provided normal values to assist the interpretation of clinical and epidemiological studies of the hand-arm vibration syndrome.

In France, a 3-D biodynamic model of a finger was elaborated to understand how vibration propagates in the tissues and how to calculate internal mechanical properties, such as strain. The studies also improved understanding of finite element calculations of visco-hyperelastic behaviour.

In Germany, experiments and modelling of the spinal system led to a new method of predicting spinal stress from vibration in vehicles. A numerical model of the spinal system was extended to predict load on the spine from the forces caused by combinations of driver posture and whole-body vibration. When applied to the vibration measured in the epidemiological studies, the evaluations indicated an underestimation of health risks by the exposure limit value in the Physical Agents (Vibration) Directive.

Supporting activities

Protocols were developed for the epidemiological studies of hand-transmitted and whole-body vibration. These defined measures of vibration dose, means of summarising exposures and their effects, and self-administered and clinically-administered questionnaires for the baseline and follow-up studies. The protocol for hand-transmitted vibration also defined tests for diagnosing the hand-arm vibration syndrome. The protocols are valuable guides for future research and should also assist clinical studies.

VIBRISKS also produced health surveillance guidance that will help occupational health workers to minimise risk, screen exposed individuals, and manage individuals with symptoms of vibration injuries.

Conclusions

The epidemiological and experimental studies of hand-transmitted vibration indicate that improvements are possible to the frequency weighting and the time-dependency currently used to predict the risks of vibration-induced disorders. The results confirm that finger systolic blood pressure after cold provocation is related to vibration exposure, and that both thermal thresholds and vibrotactile thresholds are indicators of sensorineural damage caused by hand-transmitted vibration.

The studies of whole-body vibration indicate that improvements are needed to the method of predicting risks to the low-back. Risks of injury to the low-back due to mechanical forces are complex and multi-factorial and cannot be predicted solely from measurements of vibration. Especially important are postural factors that have been shown to influence spinal forces and the risk of low back pain.

The findings have implications for the Physical Agents (Vibration) Directive of the EU and the development of new standards. However, the subject is very complex and there are many implications associated with any change to current procedures. Further research on hand-transmitted and whole-body vibration is required before specific changes can be confidently recommended.

Benefits and Beneficiaries

VIBRISKS has contributed to the prevention and control of vibration-induced disorders by disseminating new methods, new findings, and experience from the project to occupational health professionals, standards committees (national, European, and International), and to employers and their workers.

The VIBRISKS Final Report and all 21 Annexes are publicly available to assist others undertaking relevant research. The VIBRISKS protocols for diagnosing vibration-induced injuries, and the VIBRISKS guidelines for the health surveillance of persons exposed to hand-transmitted vibration or whole-body vibration, are available for application by occupational health workers across Europe and worldwide.

Two international conferences and workshops were organised by the VIBRISKS project team to disseminate information from the project: (i) the 3rd International Conference on Whole-body Vibration Injuries in Nancy, France (7-9 June 2005) and (ii) the 2nd International Workshop on HTV Injuries in Gothenburg, Sweden (6-7 September 2006). The results are also presented in many papers already published or awaiting publication in scientific journals.