Risks of Occupational Vibration Exposures

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Title: Longitudinal epidemiological surveys in the Netherlands of drivers exposed to whole-body vibration

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SUMMARY

This document reports the findings of a prospective cohort study on dose-response relationship for low back pain (LBP) disorders in drivers exposed to whole-body vbration (WBV) in the Netherlands. The Dutch study population included at the start 574 male professional drivers employed in 13 different companies in agriculture, manufacturing industries, construction, public utility and transport industry throughout the country, using loaders, excavators and other earth moving equipment, mobile cranes, lorries, lawn mowing machines, asphalt machines, tractors, and small boats. At the 1st follow-up survey, 467 drivers were left from the original cohort.

Vibration measurements in a representative sample of the machines and vehicles used by the various driver groups were combined with real time observation of tasks and postures by a validated observation system, Palmtrac®. Personal, occupational and health histories of the included workers were collected by means of the Dutch version of a standardized questionnaire developed within the VIBRISKS project. In order to explore the evidence in the research about which preventive strategies are successful in reducing vibration magnitude in the workplace, a systematic review of the literature was carried out.

Daily vibration exposure in terms of vibration total value $A_v(8)$ in the companies ranged from 0.27 (small boats) to 1.20 ms^{-2} r.m.s. (wheeled loaders). The period prevalence of the various LBP symptoms varied from 36.5% (episodes of acute LBP) to 57.8% (LBP in last 12 months). Over the follow-up period (2005-2006), the incidence of the various LBP symptoms ranged from 9.1% (acute LBP) to 25.7% (LBP in last 12 months). In general, the relation between the various LBP outcomes and the different measures of daily vibration exposure was inconsistent, except for daily driving time. Regarding the various measures of cumulative vibration doses, more significant relationships and trends with LBP outcomes were seen, in particular for the occurrence of an episode of acute LBP in the previous 12 months. The results of the exposure-response analysis show, however, no consistency over the whole range of LBP outcomes. Several physical and postural load factors, as assessed by responses to the questionnaire, were significant predictors of LBP, but comparison of the questionnaire responses with real time observation showed that the time spent in some unfavourable postures or tasks were underestimated by the workers while other were overestimated. So far, a clear exposure response pattern could not be derived from the results of this study but pooling of the data of the different partners may give a more reliable picture. The real time observations at the workplace and the systematic review on vibration reduction were of help in tailoring a controlled intervention study that is still ongoing in a sub sample of the study population.

CONTENTS

1 Introduction

Low back pain (LBP) and back disorders are among the most common and costly health problems. Occupational, non-occupational, and individual risk factors play a role in the development, the duration, and the recurrence of LBP. Several systematic reviews have synthesized and discussed the evidence on WBV as an occupational risk factor for back disorders[1-7]. All these reviews conclude that there is moderate to strong epidemiological evidence for a relation between occupational exposure to whole-body vibration (WBV) and LBP. Whether this exposure is only a modest or a substantial risk factor for the onset and recurrence of LBP is still a matter of debate. Recently, also some studies were published in which the relationship between WBV and back disorders was not confirmed[8-10]. Nevertheless, in five European countries (Belgium, Germany, Netherlands, France, and Denmark), LBP and back disorders due to WBV are, when meeting certain criteria, currently recognised as an occupational disease[11]. High exposures still occur as WBV is a common occupational risk factor, affecting 4% to 8% of the workforce in industrialised countries[12-13]. Important high risk groups are drivers of off-road vehicles (earth moving, forestry, and agricultural machines), drivers of forklift trucks, lorries, or buses, crane operators, and helicopter pilots. Daily exposure to WBV for 8 hour with an average magnitude above 0.5 ms^{-2} rms in the dominant axis may significantly contribute to the occurrence of back disorders. In the recent European Guideline this value has been adopted to distinguishing between possible hazardous and harmless work situations[14]. This ‘action value’ does not take into account differences in magnitude and direction of the vibration spectrum and, in addition, most likely underestimates the risk associated with short-term exposure to high magnitude. Hence, a better insight is needed in clear exposure–response relationships for the association of frequency, duration, magnitude, and direction of the vibration spectrum with back disorders.

This study reports the findings of a prospective cohort study on dose-response relationship for low back pain disorders in WBV-exposed drivers in the Netherlands. The study is conducted as part of a four-year research project entitled “*Risks of Occupational Vibration Injuries* (VIBRISKS)” and was funded by the EU Commission.

1.1 Objectives

The aim of this study was to investigate the prevalence and incidence of LBP outcomes in various groups of professional drivers in the Netherlands. Vibration measurements in a representative sample of the machines and vehicles used by the various driver groups were combined with real time observation of tasks and postures by a validated observation system, Palmtrac®. The association between LBP, WBV exposure, physical load factors, and psychosocial variables was investigated while controlling for potential individual confounders recognised as risk factors for LBP. In order to explore the evidence in the research about which preventive strategies are successful in reducing vibration magnitude in the workplace, a systematic review of the literature was carried out. The results were used to design an experimental intervention programme that is implemented in a sub sample of the study populations.

2 Methods

2.1 Study population

The Dutch study population included at the start 574 male professional drivers employed in 13 different companies in agriculture, manufacturing industries, construction, public utility and transport industry throughout the country. A minimum of one year of professional driving in the current job was established as the basic criterion for the inclusion of drivers in the study population. The most important vehicles that in this cohort of drivers were driven occupationally were: wheeled loaders, excavators and other earth moving equipment, mobile cranes, lorries, lawn mowing machines, asphalt machines, tractors, and small boats.









Informed consent to the study was obtained from employers and employees at each company. At the 1st follow-up survey, 466 drivers were left from the original cohort. The most important reasons for drop out were the bankruptcy of one of the participating companies and retirement of some of the drivers. The response to the questionnaire study was 318 (56%) at the baseline survey and 266 (57%) at the 1st follow-up survey (Table 1).

Table 1. Study population and response in the companies at baseline and at follow-up

Company (N=13)	Baseline N	Follow up N	Baseline Respons Q	Follow-up Respons Q	Number of measured vehicles	Number of measured vehicles
1.	24	14	11 (46%)	10 (71%)	2	2
2.	17	16	10 (59%)	8 (50%)	5	5
3.	46	40	25 (54%)	23 (58%)	6	6
4.	28	17	13 (46%)	6 (35%)	5	3*
5.	3	3	2 (67%)	2 (67%)	2	2
6.	47	xxxx	24 (51%)	xxxx	2	2
7.	22	18	13 (59%)	11 (61%)	4	4
8.	5	4	5 (100%)	4 (100%)	2	2
9.	156	129	57 (37%)	54 (42 %)	4	4
10.	11	11	11 (100%)	10 (91%)	2	2
11.	7	6	6 (86%)	4 (67%)	3	3
12.	15	15	13 (87%)	12 (80%)	4	4
13.	193	193	128 (66%)	121 (63%)	8	8
Total	**574**	**466**	**318 (56%)**	**266 (57%)**	**49**	**47**

2.2 Questionnaire

Personal, occupational and health histories of the included workers were collected by means of the Dutch version of a standardized questionnaire originally developed within the European project VINET (*Vibration Injury Network*) and further adapted within Work Package 4 of the VIBRISKS project. All questionnaire data have been stored in an Access database. The self-administered questionnaire included 42 questions and required 30-40 minutes to be completed. The questionnaire is divided into five main parts:

- Personal characteristics, habits and sporting activities.
- The current job and its environment with questions about the working activities (lifting, digging, postures etc) and the vehicles which are being driven (type of vehicles, time spend driving etc).
- Previous jobs that may have been held (at least for one year)

- Health: pain, other symptoms and disability in different parts of the body (low back, neck and shoulders) in different time domains (last 7 days and last 12 months)
- Psychosocial questions

Definition of LBP outcomes on the basis of the items in the questionnaire

- **LBP**: pain or discomfort in the low back area (indicated in a figure), with or without radiating pain in one or both legs, lasting one day or longer in the previous seven days (7-day LBP) or the previous twelve months (12-month LBP).
- **High pain intensity**: LBP in the previous 12 months associated with a pain score ≥ 5 (Von Korff scale).
- **LBP disability**: last episode of LBP associated with a disability score ≥ 12 (Roland & Morris scale).
- **Sciatic pain**: radiating pain in one or both legs in the previous 12 months.
- **Acute LBP**: sudden attack of low back pain producing abnormal or locked posture of the back in the previous 12 months.
- **Treated LBP**: low back pain treated with anti-inflammatory drugs or physical therapy in the previous 12 months.
- **Sick leave**: sick leave > 2 days or > 7 days due to LBP in the previous 12 months.

The questionnaire with accompanying letter, information brochure, informed consent and pre paid envelope was sent by mail to each participant. Each questionnaire was coded by a reference number so that privacy was taking into account. Within 18 days reminder letters were send to the participants who did not respond to the first request of completing the questionnaire.

2.3 Measurement and assessment of vibration exposure

Vibration measurements were made on representative samples of industrial machines and vehicles used by the professional drivers (n=49 at the baseline survey and n=47 at the 1st follow-up survey). Vibration was measured at the driver-seat interface during actual operating conditions according to the recommendations of the International Standard ISO 2631-1[15] using a triaxial seat accelerometer (including DIN-microdot Cable WL 0547). The 3-axis recorded signals were amplified, converted to voltage and filtered with type 1700 (Brűel & Kjaer) 3-channel human-vibration front end, with one channel connected to a 2260-I observer modular precision sound analyzer (Brűel & Kjaer). Frequency-weighted root mean square (r.m.s.) accelerations (Ax, Ay and Az) were obtained from one third octave band frequency spectra (1-80 Hz) of the signal recorded in the back-to-chest direction (x-axis), right-to-left direction (y-axis) and vertical direction (z-axis), using the ISO 2631-1 weighting factors. From one-third octave band frequency spectra (1-80 Hz) recorded from *x*-, *y*-, and *z*-directions, frequency-weighted root-mean-square (r.m.s.) accelerations (a_{wx}, a_{wy}, a_{wz}) were obtained by using the weighting factors suggested by ISO 2631-1.

The WBV measurement data were exported and stored in an Excel spreadsheet, using the Noise Explorer type 7815 version 4.7 software. For further analysis, the first two minutes of the total recorded time were deleted, as it was necessary to install both the equipment and the driver properly. In addition, zero values due to measurement artefact in the measurement were deleted and extrapolated, using the average of the values one second before and one second after the zero value, as the WBV signal was logged every second.

The vibration total value (or vector sum) of the weighted r.m.s. accelerations, a_v, was calculated according to the following formula: $a_v = [(1.4a_{wx})^2 + (1.4a_{wy})^2 + a_{wz}^2]^{½}$ (ms^{-2} r.m.s.).

For each operator, questionnaire data were used to estimate daily exposure to WBV expressed in driving hours, as well as the total duration of exposure to WBV in full-time driving years. Daily vibration exposure was expressed in terms of 8-h energy-equivalent frequency-weighted acceleration magnitude (*A*(8)) according to the EU Directive on mechanical vibration: $A(8) = a_w\ (T/T_0)^{½}$ (ms^{-2} r.m.s.). In accordance with a proposal, elaborated in the VIBRISKS project, vibration total value and duration of exposure were used to construct measures of cumulative vibration dose estimated as: $dose = \sum_i [a_i^m t_i]$ where a_i is the vibration total value of the frequency-weighted accelerations measured on machine *i* driven for time t_i in hours (h/d × d/yr × years). In this way, individual WBV exposure doses were calculated in accordance with the protocol for calculation of dose measures for whole-body vibration (WP4-N14).

2.4 Assessment of physical load, tasks and postures

The physical work demands and the tasks and postures of the drivers included in this study were assessed in two different ways: (1) with the afore-mentioned questionnaire and (2) with the PalmTrac system during observation at the workplace. The PalmTrac system is a direct observational method, originally developed at the Robens Institute (University of Surrey, UK) and further adapted by the AMC and Health/ERGOcare (Free University Amsterdam) and it allows on-site data recording of tasks, activities and postures on a palmtop (Figure 1).

For each observed driver, data were recorded for approximately four hours. In addition to the questionnaire data, the PalmTrac measurements yield information about the tasks and postures more in detail. Results from ten drivers were used for the comparison between the subjective and objective assessments of physical work demands. All of the questions in the self-administered questionnaire were related to an entire working day (8 hours). To standardize the PalmTrac data also to an entire working day, the exact PalmTrac recording time (in minutes) was calculated as a proportion of eight hours (480 minutes). This proportion was multiplied by the total recorded time for each of the five physical work demands.

Moreover, the simultaneous measurement of tasks and postures and exposure to WBV provides insight into the tasks, activities, and postures that are performed at the time of a minimum or maximum level in the vibration signal and this information was used in the tailoring of an intervention programme. To ensure that the PalmTrac system and the WBV measurement would work simultaneously, the start of the measurements were synchronized.

Figure 1: Different steps involved in the use of the PalmTrac system

2.5 Systematic review of strategies to reduce WBV exposure of drivers

Since an adverse relationship between exposure to WBV and LBP is assumed, implementing effective preventive strategies to reduce exposure to vibration can contribute to a decrease in LBP. Our aim in this part of the study was to explore research evidence to determine which preventive strategies are successful in reducing vibration exposure in the workplace. Therefore, a systematic literature search was performed in the electronic databases PubMed (biomedical literature), Embase (biomedical and pharmacological literature), ScienceDirect (science, technology, and medical literature), and Osh-Rom (occupational safety and health related literature, including databases RILOSH, MIHDAS, HSELINE, CISDOC, and NIOSHTIC2). Only original articles, dealing with human laboratory or field studies, published between 1985 and 2005 in which the effect on outcome values were identifiable and clearly presented were included in the review. Because our goal was primarily to explore which intervention measures were successful in reducing exposure to WBV, we did not apply further methodological criteria in the selection of articles.

2.6 Data analysis

The statistical analysis of the epidemiological survey was performed using SPSS 12.0.1 for Windows and SAS 9.1. Continuous variables were summarised with the mean or median as measures of central tendency and the standard deviation (SD) or quartiles as a measure of dispersion. The difference between groups was tested with either one-way analysis of variance (ANOVA) or the Kruskal Wallis test. The difference between categorical data cross-tabulated into contingency tables was tested by chi-square statistic. Point prevalence, period prevalence, and cumulative incidence of low back symptoms over the follow-up period were estimated by means of traditional statistical methods for epidemiological data.

Initially, univariate associations were examined to study the effect of various predictors on the occurrence of low back complaints. Then, multivariate random-intercept logistic regression models were used to assess the association between LBP outcomes over time and exposure variables (vibration and physical load) while controlling for the influence of personal and psychosocial factors. Both exposure variables and confounding factors entered in the logistic model as categorical covariates, except for age, which was used as a continuous covariate. The significance of additional variables in the model was tested by the likelihood ratio (LR) chi-square statistic. Independent variables were retained in the model when their probability value was < 0.10. Age was included in each model regardless of the level of statistical significance.

The association between LBP outcomes and several independent variables over time was assessed by logistic regression analysis according to the transition model. Odds ratios and 95% confidence intervals (95% CI) were estimated from the logistic regression coefficients and their standard errors. The magnitude of the likelihood ratio (LR) chi-square statistic was used to assess the "importance", in statistical terms, of the various alternative measures of vibration exposure for the prediction of the outcome.

3 Results

3.1 Vibration exposure

Table 2 shows the mean vibration magnitudes (weighted r.m.s. accelerations) of the most important vehicles that were measured at the baseline survey. Daily driving time in the participating companies varied from 3.0 hours (lawn mowing machines) to 9.8 hours (lorries in road transport). Daily vibration exposure in terms of $A_v(8)$ in the companies ranged from 0.27 (operators of small boats) to 1.20 ms^{-2} r.m.s. (drivers of wheeled loaders), (p<0.001). Similarly, daily vibration exposure in terms of VDV_{sum} ranged from 8.6 $ms^{-1.75}$ (boats) to 14.9 $ms^{-1.75}$ (drivers of earth moving machines).

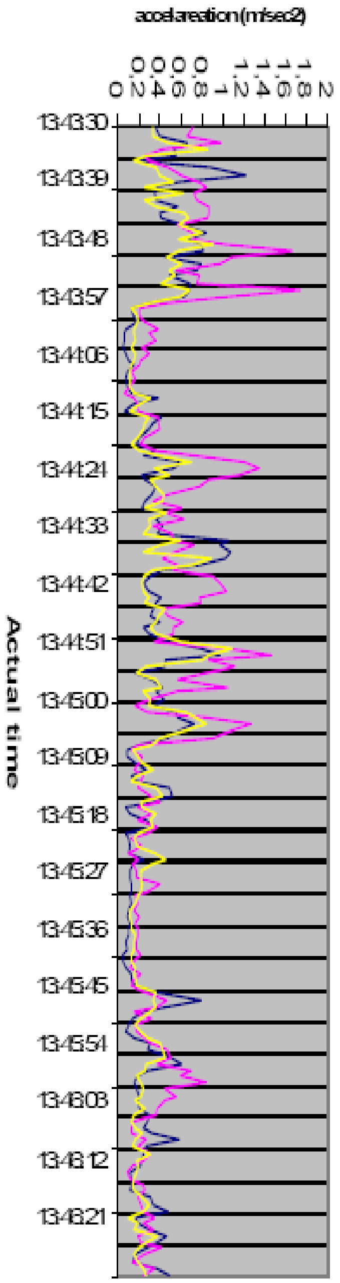
Table 2. Mean vibration magnitudes (weighted r.m.s. accelerations) of the dominant vehicle categories measured at the baseline survey.

Category vehicle	Number of vehicles measured	Ax [range] (m/s^2)	Ay [range] (m/s^2)	Az [range] (m/s^2)	Av [range] (m/s^2)
Lawn mowing machines	9	0,54 [0,34-0,83]	0,53 [0,24-0,87]	0,52 [0,40-0,81]	1.05 [0.7-1.3]
Shovel	8	0,73 [0,59-0,86]	0,71 [0,48-0,90]	0,52 [0,43-0,69]	1.25 [1.01-1.47]
Tractor	3	0,52 [0,30-0,51]	0,51 [0,27-0,41]	0,34 [0,10-0,25]	0.88 [0.46-1.28]
Road Roller	2	0,22 [0,07-0,37]	0,21 [0,06-0,25]	0,21 [0,08-0,34]	0.43 [0.14-0.65]
Lorry	4	0,26 [0,21-0,30]	0,26 [0,18-0,34]	0,39 [0,26-0,57]	0.65 [0.45-0.88]
Crane	2	0,05 [0,03-0,06]	0,04 [0,04-0,04]	0,06 [0,03-0,07]	0.10 [0.08-0.12]
Dumper	5	0,25 [0,16-0,29]	0,25 [0,18-0,30]	0,34 [0,24-0,48]	0.60 [0.41-0.77]
Excavator	7	0,40 [0,19-0,66]	0,31 [0,11-0,67]	0,30 [0,16-0,52]	0.66 [0.36-1.19]
Bulldozer	2	0,41 [0,33-0,47]	0,27 [0,26,-0,27]	0,56 [0,44-0,65]	0.91 [0.82-1.0]
Boat	2	0,12 [0,08-0,15]	0,19 [0,13-0,24]	0,10 [0,08-0,12]	0.27 [0.19-0.33]

3.1.1 Relation between vibration exposure and physical tasks

Figure 2 shows an example of the simultaneous assessment of WBV magnitude and observed physical load, tasks and postures.

Figure 2. Example of a result of the simultaneous assessment of physical work demands and WBV measurement for one driver



1.Task 2.Activity 3.Within activity	Physical work Demand	m/s² Ax	Ay	Az
2 – activity	Sitting			
1 – task	Leveling-off	0,27	0.42	0,15
2 – activity	Sitting	0.88	1.07	0.54
3 – within activity	Sitting twisted/ leaning back	0,96	1.53	0,60
2 – activity	Sitting	0,22	0,36	0,80
2 – activity	Sitting (driving without load)	0,67	0,97	0,44
2 – activity	Sitting	0,61	0,53	0,37
1 - task	Transport	0,29	0,38	0,28
2 – activity	Sitting	0,14	0,24	0,28
2 – activity	Sitting (Driving with load)	0,35	0,47	0,24
1 - task	Leveling off	0,34	0,18	0,16
2 – activity	Sitting twisted/ leaning back	0,41	0,34	0,21
2 – activity	Sitting (Driving with load)			

3.2 Health outcomes

3.2.1 Prevalence and incidence of LBP symptoms

Table 3 reports the most important health outcomes, measured by the questionnaire responses during the baseline and the follow-up survey. These results show reasonable stability over time.

Table 3. Low back pain (LBP) symptoms and other health outcomes at the baseline survey (T0) and the 1st follow-up survey (T1).

	T0	T1
Average daily exposure duration	7.9 hour (± 2.7)	7.8 hour (± 3.1)
Average years of exposure	17.4 year (± 12.1)	18.4 year (± 13.1)
% with LBP in last 7 days	**30.2%** (N=96)	**35.1%** (n=93)
% with LBP in last 12 months	**54.7%** (N=174)	**59.2%** (n=157)
VAS score for Low Back	**4.3** (median: 4)	**4.2** (median: 4)
Roland Morris Disability scale	**6.2** (median: 4.5)	**5.3** (median: 4)
% with neck pain in last 7 days	**18.6%** (N=59)	**16.7%** (N=44)
% with neck pain in last 12 months	**33.3%** (N=106)	**26.8%** (N=71)
VAS score for neck pain	**4.6** (median: 5)	**4.67** (median: 4)
% with shoulder pain in last 7 days	**17.3%** (N=53)	**14.3%** (N=38)
% with shoulder pain in last 12 months	**28.3%** (N=90)	**26.4%** (N=70)
VAS score for shoulder pain	**4.7** (median 4)	**4.51** (median 4)

The further section of this report provides primarily information on the findings of the epidemiological surveys of the drivers with complete follow-up (i.e. those who participated in survey 1 and 2, n=230). Table 4 shows the period prevalence (2005-2006) and the cumulative incidence over the follow-up period for LBP in the participating populations. The period prevalence of the various LBP symptoms varied from 36.5% (episodes of acute LBP) to 57.8% (overall LBP in last 12 months). About 6% of the subjects complained about severe disability due to LBP (Roland & Morris disability scale score ≥ 12) in the last episode. Sick leave due to LBP in the previous 12 months was reported by 8.7% (> 7 days) of the subjects. Over the follow-up period (2005-2006), the incidence of the various LBP symptoms ranged from 9.1% (acute LBP) to 25.7% (LBP in last 12 months).

Table 4. Period prevalence and one-year incidence of low back pain (LBP) symptoms in the total sample of professional drivers (n=230) that responded to both surveys.

LBP outcome	Prevalence (%)	Incidence (%)
LBP in the previous 7 days	32.6	18.2
LBP in the previous 12 months	57.8	25.7
Episodes of acute LBP in the previous 12 months	36.5	9.1
Episodes of sciatica in the previous 12 months	21.7	10.4
Duration of LBP > 30 days/year in the previous 12 months	12.3	7.8
High back pain intensity in the previous 7 days (VAS score > 5)	8.3	5.6
Disability due to the last episode of LBP (Roland & Morris scale score ≥ 12)	5.7	1.7
Visit to a doctor for LBP in the previous 12 months	20.4	7.8
LBP treated with medication or physical therapy in the previous 12 months	21.3	6.5
Sick leave > 2 days due to LBP in the previous 12 months Sick leave > 7 days due to LBP in the previous 12 months	13.0 8.7	5.6 5.2

3.2.2 Low back pain and personal characteristics

Univariate analysis showed that in the overall study population severe LBP outcomes (high pain intensity, LBP disability, acute LBP, and sciatica) tended to increase over time with the increase of age (Tables 5a and 5b). An increased occurrence of acute LBP symptoms was found for smoking. Except for sciatica, no clear relationship was shown between the various LBP outcomes and body mass index (BMI). Previous job with high physical load was associated with 7-day LBP and with acute LBP.

Table 5a. Binary logistic regression for the association between low back pain (LBP) symptoms (7-day LBP, 12-month LBP, high pain intensity in the lower back (Von Korff pain scale score > 5) during the previous 12 months, disability (Roland & Morris disability scale score ≥ 12) during the last episode of LBP) and various individual factors in the professional drivers (n=230) over one-year follow-up period. odds ratios (OR) and 95% confidence intervals (95% CI) are adjusted by age and follow-up time.

Factors		7-day LBP	12-month LBP	High pain intensity	LBP disability
		OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Age (yr)	≤35	(-)	(-)	(-)	(-)
	36-41	1.11 (0.56-2.20)	1.55 (0.76-3.16)	0.45 (0.08-2.47)	3.34 (0.28-39.69)
	42-48	0.95 (0.52-1.73)	1.20 (0.66-2.17)	1.31 (0.39-4.45)	6.27 (0.68-57.43)
	>48	0.96 (0.58-1.59)	0.68 (0.41-1.11)	2.44 (0.89-6.66)	7.28 (0.91-58.50)
BMI (kg/m^2)	<25	(-)	(-)	(-)	(-)
	25-27	1.17 (0.69-1.98)	1.01 (0.60-1.69)	0.72 (0.26-1.98)	0.50 (0.12-2.02)
	>27	1.20 (0.75-1.91)	0.95 (0.60-1.50)	0.90 (0.37-2.15)	0.93 (0.30-3.81)
Smoking	no smoking	1.0 (-)	(-)	(-)	(-)
	ex-smoker	1.09 (0.66-1.78)	1.47 (0.91-2.36)	1.48 (0.56-3.90)	0.47 (0.12-1.76)
	current smoker	1.44 (0.91-2.27)	1.32 (0.85-2.07)	2.16 (0.89-5.24)	1.09 (0.38-3.16)
Married	no	1.0 (-)	1.0 (-)	1.0 (-)	1.0 (-)
	yes	1.59 (0.82-3.07)	2.11 (1.15-3.88)	1.41 (0.40-4.95)	1.16 (0.13-10.54)
Previous jobs with	no	(-)	(-)	(-)	(-)
WBV exposure	yes	1.17 (0.79-1.71)	1.29 (0.86-1.88)	0.83 (0.44-1.59)	0.47 (0.18-1.18)
Previous job with	no	(-)	(-)	(-)	(-)
heavy physical load	yes	1.85 (1.25-2.74)	1.36 (0.93-2.00)	1.17 (0.61-2.24)	0.73 (0.29-1.86)

Table 5b. Binary logistic regression for the association between low back pain (LBP) symptoms in the previous 12 months (acute LBP, sciatica, treated LBP, sick leave due to LBP) and various individual factors in the professional drivers (n=230) over one-year follow-up period. Odds ratios (OR) and 95% confidence intervals (95% CI) are adjusted by age and follow-up time.

Factors		Acute LBP	Sciatica	Treated LBP	Sick leave (>7 days)
		OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Age (yr)	≤35	1.0 (-)	1.0 (-)	1.0 (-)	1.0 (-)
	36-41	2.00 (1.02-3.92)	2.16 (0.88-5.30)	1.45 (0.56-3.77)	1.29 (0.28-5.97)
	42-48	1.05 (0.58-1.91)	2.31 (1.05-5.09)	2.19 (0.99-4.84)	2.71 (0.81-8.98)
	>48	0.73 (0.44-1.23)	2.46 (1.22-4.96)	2.00 (0.98-4.08)	1.96 (0.60-6.00)
BMI (kg/m^2)	<25	1.0 (-)	1.0 (-)	1.0 (-)	1.0 (-)
	25-27	1.13 (0.67-1.91)	0.80 (0.40-1.61)	0.84 (0.44-1.60)	1.15 (0.45-2.98)
	>27	0.93 (0.58-1.49)	2.16 (1.23-3.88)	0.91 (0.52-1.59)	1.05 (0.40-2.50)
Smoking	no smoking	1.0 (-)	1.0 (-)	1.0 (-)	1.0 (-)
	ex-smoker	2.03 (1.22-3.37)	1.16 (0.66-2.02)	1.45 (0.79-2.64)	2.04 (0.80-5.17)
	current smoker	1.81 (1.13-2.90)	1.06 (0.62-1.83)	1.40 (0.79-2.50)	1.87 (0.75-4.66)
Married	no	1.0 (-)	1.0 (-)	1.0 (-)	1.0 (-)
	yes	1.99 (1.02-3.90)	1.70 (0.72-4.02)	1.02 (0.46-2.26)	1.23 (0.34-4.39)
Previous jobs with WBV exposure	no	1.0 (-)	1.0 (-)	1.0 (-)	1.0 (-)
	yes	1.36 (0.92-2.01)	0.96 (0.62-1.52)	0.74 (0.46-1.19)	0.87 (0.43-1.74)
Previous job with heavy physical load	no	1.0 (-)	1.0 (-)	1.0 (-)	1.0 (-)
	yes	2.03 (1.37-3.01)	1.40 (0.89-2.20)	1.00 (0.62-1.62)	1.95 (0.96-3.97)

3.2.3 LBP and physical work factors

Overall, work-related physical load factors, treated as dichotomous variables, were positively related to many of the LBP outcomes (Tables 6a and 6b). Lifting and awkward postures at work, such as trunk bent at work, trunk twisting while lifting loads or back bent forward, showed significant associations with back pain, pain intensity, disability, treated LBP, and sciatic pain.

3.2.4 LBP and psychosocial variables

Job dissatisfaction in general showed a clear and statistical significant relationship with the various LBP outcomes: the more dissatisfied, the higher the chance of having or developing back pain. When workers were more satisfied about there job opportunities, the chance of having or developing back pain was significantly lower. For the other psychosocial variables, no clear pattern of association between LBP and psychosocial factors at work was observed in the study population.

Table 6a. Binary logistic regression for the association between low back pain (LBP) symptoms (7-day LBP, 12-month LBP, high pain intensity in the lower back (Von Korff pain scale score > 5) during the previous 12 months, disability (Roland & Morris disability scale score ≥ 12) during the last episode of LBP) and various physical load factors in the professional drivers (n=230) over one-year follow-up period. odds ratios (OR) and 95% confidence intervals (95% CI) are adjusted by age and follow-up time.

Factors		7-day LBP	12-month LBP	High pain intensity	LBP disability
		OR (95% CI)	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**
Sitting > 3h at work	no	1.0 (-)	1.0 (-)	1.0 (-)	1.0 (-)
	yes	1.01 (0.68-1.49)	0.99 (0.68-1.45)	0.69 (0.36-1.34)	0.83 (0.32-2.16)
Trunk bent at work	no	1.0 (-)	1.0 (-)	1.0 (-)	1.0 (-)
	yes	1.41(0.94-2.12)	1.80 (1.18-2.72)	2.29 (1.19-4.41)	1.95 (0.75-5.05)
Trunk twisted at work	no	1.0 (-)	1.0 (-)	1.0 (-)	1.0 (-)
	yes	1.31 (0.88-1.95)	1.20 (0.81-1.78)	3.05 (1.57-5.93)	2.18 (0.84-5.67)
Lifting at work	no	1.0 (-)	1.0 (-)	1.0 (-)	1.0 (-)
	yes	1.95 (1.30-2.91)	1.80 (1.20-2.67)	4.37 (2.18-8.80)	2.51 (0.93-6.81)
Lifting & bending	no	1.0 (-)	1.0 (-)	1.0 (-)	1.0 (-)
at work	yes	1.91 (1.28-2.84)	1.73 (1.18-2.53)	3.97 (1.78-8.85)	2.58 (0.81-8.25)
Lifting & twisting	no	1.0 (-)	1.0 (-)	1.0 (-)	1.0 (-)
at work	yes	2.15 (1.43-3.22)	1.50 (1.00-2.25)	4.43 (2.22-8.84)	2.72 (1.01-7.34)
Back bent forward or	no	1.0 (-)	1.0 (-)	1.0 (-)	1.0 (-)
twisted while driving	yes	1.19 (0.80-1.76)	1.02 (0.69-1.49)	0.82 (0.43-1.56)	0.89 (0.34-2.35)

Table 6b. Binary logistic regression for the association between low back pain (LBP) symptoms in the previous 12 months (acute LBP, sciatica, treated LBP, sick leave due to LBP) and various physical load factors in the professional drivers (n=230) over one-year follow-up period. odds ratios (OR) and 95% confidence intervals (95% CI) are adjusted by age and follow-up time.

Factors		Acute LBP	Sciatica	Treated LBP	Sick leave (> 7 days)
		OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Sitting > 3h at work	no	1.0 (-)	1,0 (-)	1.0 (-)	1.0 (-)
	yes	1.09 (0.74-1.61)	0.84 (0.53-1.33)	1.06 (0.66-1.71)	0.53 (0.25-1.11)
Trunk bent at work	no	1.0 (-)	1.0 (-)	1.0 (-)	1.0 (-)
	yes	1.82 (1.21-2.75)	1.91 (1.19-3.05)	1.40 (0.86-2.30)	2.00 (0.98-4.07)
Trunk twisted at work	no	1.0 (-)	1.0 (-)	1.0 (-)	1.0 (-)
	yes	1.48 (0.99-2.21)	1.86 (1.17-2.95)	1.40 (0.86-2.28)	2.21 (1.09-4.50)
Lifting at work	no	1.0 (-)	1.0 (-)	1.0 (-)	1.0 (-)
	yes	1.99 (1.33-2.96)	2.06 (1.30-3.27)	2.15 (1.33-3.49)	2.60 (1.26-5.32)
Lifting & bending	no	1.0 (-)	1.0 (-)	1.0 (-)	1.0 (-)
at work	yes	2.14 (1.43-3.20)	2.46 (1.52-3.98)	2.24 (1.36-3.71)	2.66 (1.21-5.86)
Lifting & twisting	no	1.0 (-)	1.0 (-)	1.0 (-)	1.0 (-)
at work	yes	2.51 (1.67-3.76)	2.43 (1.53-3.86)	2.50 (1.54-4.07)	3.16 (1.54-6.49)
Back bent forward or	no	1.0 (-)	1.0 (-)	1.0 (-)	1.0 (-)
twisted while driving	yes	1.09 (0.73-1.61)	0.81 (0.51-1.26)	1.53 (0.94-2.51)	1.60 (0.75-3.40)

3.2.5 LBP and vibration exposure

To assess a possible exposure-response relationship for LBP outcomes in the professional drivers, measures of vibration exposure, such as *A*(8), *VDV*, duration of exposure in years, and vibration doses of the form $\sum[a_i^m t_i]$, were divided into quartiles assuming the lowest quartile as the reference category. Tables 7 and 8 show, as examples (the other results are reported in the appendix to this Annex), the results of the logistic regression analysis for the relation over time between LBP in the last 12 months and daily vibration exposure (Table 7) and between an episode of acute LBP in the previous 12 months and cumulative vibration exposures (Table 7), while adjusting for several covariates such as age, physical load factors, and psychosocial factors. In general, the relation between the various LBP outcomes and the different measures of daily vibration exposure was inconsistent. Only daily driving time was significantly associated with some of the LBP outcomes: acute LBP in the last 12 months, treated LBP, sciatica, high intensity pain and LBP disability (Roland Morris disability scale ≥ 12). Patterns of increased risk for sick leave > 7 days due to LBP in the previous 12 months were found for all the different measures of daily vibration exposure. Regarding the various measures of cumulative vibration doses, more significant relationships and trends with LBP outcomes were seen. Most significant relations between the defined LBP outcomes and the measures of cumulative WBV exposure are found with dose $\sum[t_i]$ and dose $\sum[a_{wsi}^2 t_i]$, however, there are also some significant relations with the other cumulative dose measures. The occurrence of LBP in the previous 12 months was significantly associated only with $\sum[t_i]$. The occurrence of episodes of an episode of acute LBP in the previous 12 months was significantly related to most of the measures of cumulative vibration dose (Table 8). The associations were strongest for $\sum[t_i]$, $\sum[a_{wqi}t_i]$, and $\sum[a_{wqi}^2 t_i]$.

Table 7. Logistic regression of *low back pain in the previous 12 months* on different measures of daily exposure to whole-body vibration (WBV) in the professional drivers (n=230) over one-year follow-up period. Odds ratio (OR) and 95% confidence interval (95% CI) are adjusted for several covariates (age, physical load factors, psychosocial factors, back trauma, and follow-up time). Each measure of WBV exposure was included as a quartile based design variable, assuming the lowest quartile as the reference category. The likelihood ratio (LR) test for the measures of WBV exposure is given

Measures of daily WBV exposure	**Quartiles of measure of daily WBV exposure**				**LR test**
	Q1	**Q2**	**Q3**	**Q4**	**(χ^2, 3*df*)**
Daily driving time (h)	5.0	8.0	9.4	11.0	
OR	1.0	0.87	1.23	1.74	4.68 (p=0.19)
(95% CI)	(-)	0.50 - 1.49	0.73 - 2.08	0.87 - 3.49	
$A_v(8)$ (ms^{-2} r.m.s.)	0.28	0.45	0.56	0.74	
OR	1.0	0.86	0.73	0.71	1.80 (p=0.61)
(95% CI)	(-)	0.48 - 1.52	0.41 - 1.30	0.41 - 1.24	
$A_{dom}(8)$ (ms^{-2} r.m.s.)	0.18	0.32	0.39	0.53	
OR	1.0	0.92	0.72	0.78	1.44 (p=0.69)
(95% CI)	(-)	0.53 - 1.57	0.40 - 1.31	0.44 - 1.39	
VDV_v ($ms^{-1.75}$)	3.20	4.90	6.46	11.83	
OR	1.0	0.49	0.67	0.85	6.92 (p=0.07)
(95% CI)	(-)	0.28 - 0.86	0.38 - 1.19	0.48 - 1.15	
VDV_{dom} ($ms^{-1.75}$)	3.26	4.56	5.81	10.34	
OR	1.0	0.85	0.84	1.16	1.56 (p=0.67)
(95% CI)	(-)	0.48 - 1.52	0.49 - 1.44	0.68 - 1.98	

Table 8. Logistic regression within the transition model of *acute low back pain in the previous 12 months* on alternative measures of cumulative exposure in most recent job, to whole-body vibration (WBV) in the professional drivers (n=230) over one-year follow-up period. Odds ratio (OR) and 95% confidence interval (95% CI) are adjusted for several covariates (Age, physical load factors, psychosocial factors, back trauma and follow-up time). Each measure of WBV exposure was included as a quartile based design variable, assuming the lowest quartile as the reference category. The likelihood ratio (LR) test for the measures of WBV exposure is given.

Measures of cumulative WBV exposure	**Quartiles of measure of cumulative WBV exposure**				**LR test**
	Q1	**Q2**	**Q3**	**Q4**	**(χ^2, 3df)**
Exposure duration (yr)	3.2	10.1	21.6	34.8	
OR	1.0	1.32	1.74	1.64	3.16 (p=0.37)
(95% CI)	(-)	0.73 - 2.40	0.93 - 3.25	0.78 - 3.44	
$\Sigma[t_i]$ (h $\times 10^3$)	4.6	16.7	34.9	60.7	
OR	1.0	1.86	2.14	3.24	9.84 (p=0.02)
(95% CI)	(-)	1.01 - 3.44	1.10 - 4.15	1.55 - 6.77	
$\Sigma[a_{wsi}t_i]$($ms^{-2}h \times 10^3$)	2.8	7.7	16.4	38.2	
OR	1.0	1.56	1.31	2.30	6.11 (p=0.11)
(95% CI)	(-)	0.85 - 2.87	0.70 - 2.47	1.15 - 4.60	
$\Sigma[a_{wsi}^2 t_i]$ ($m^2s^{-4}h \times 10^3$)	1.1	4.0	8.9	26.9	
OR	1.0	1.65	1.37	2.03	5.14 (p=0.16)
(95% CI)	(-)	0.91 - 3.00	0.74 - 2.52	1.06 - 3.88	
$\Sigma[a_{wsi}^4 t_i]$ ($m^4s^{-8}h \times 10^3$)	0.29	1.2	3.3	14.1	
OR	1.0	1.05	1.19	1.36	1.17 (p=0.76)
(95% CI)	(-)	0.58 - 1.88	0.66 - 2.13	0.74 - 2.49	
$\Sigma[a_{wqi}t_i]$ ($ms^{-2}h \times 10^3$)	1.95	5.60	12.16	27.73	
OR	1.0	1.88	1.43	3.13	12.09 (p=0.007)
(95% CI)	(-)	1.02 - 3.44	0.75 - 2.72	1.58 - 6.21	
$\Sigma[a_{wqi}^2 t_i]$ ($m^2s^{-4}h \times 10^3$)	0.59	2.36	4.94	14.49	
OR	1.0	1.87	1.41	2.35	7.77 (p=0.05)
(95% CI)	(-)	1.03 - 3.41	0.76 - 2.60	1.23 - 4.49	
$\Sigma[a_{wqi}^4 t_i]$ ($m^4s^{-8}h \times 10^3$)	0.1	0.36	0.99	4.09	
OR	1.0	0.87	1.31	1.30	2.53 (p=0.47)
(95% CI)	(-)	0.48 - 1.57	0.73 - 2.33	0.71 - 2.37	

3.2.6 Low back pain and other physical load factors

After adjustment for potential confounders, the occurrence of LBP in the last 12 months was significantly associated with lifting at work, lifting and bending at work, and lifting and twisting at work (Table 9). When the several physical load variables from the questionnaire were averaged within each subject to obtain a combined physical load index, the adjusted ORs showed a clear pattern of increasing risk over time for almost all LBP outcomes.

Table 9. Random-intercept logistic regression of 12-month LBP and LBP disability (Roland & Morris disability scale score ≥ 12) on work-related physical load variables in the professional drivers over a one-year follow-up period. Odds ratio (OR) and 95% confidence interval (95% CI) are adjusted for several covariates (individual characteristics, vibration exposure, back trauma, previous jobs at risk, and survey).

Variable		12-month LBP		LBP disability	
		OR (95% CI)		OR (95% CI)	
Walking & standing at work	never	1.0 (-)		1.0 (-)	
	<1 h/d	1.31	(0.67 - 2.55)	1.17	(0.22 - 6.07)
	1-3 h/d	1.14	(0.68 - 1.91)	1.07	(0.29 - 3.93)
	>3 h/d	1.07	(0.67 - 1.69)	1.71	(0.58 - 5.03)
Trunk bent 20° to 40°	never	1.0 (-)		1.0 (-)	
	<1 h/d	1.85	(0.94 - 3.62)	2.53	(0.65 - 9.93)
	1-2 h/d	2.46	(1.31 - 4.62)	2.20	(0.66 - 7.37)
	>2 h/d	1.19	(0.63 - 2.27)	3.30	(0.97 - 11,20)
Trunk bent > 40°	never	1.0 (-)		1.0 (-)	
	<0.5 h/d	2.11	(1.17- 3.83)	4.04	(1.33 - 12.23)
	0.5-2 h/d	1.51	(0.85 - 2.68)	1.45	(0.38 - 5.48)
	>2 h/d	1.44	(0.56 - 3.74)	4.25	(0.83 - 21,61)
Trunk twisted & bent 20° to 40°	never	1.0 (-)		1.0 (-)	
	<1 h/d	1.26	(0.72 - 2.20)	1.10	(0.23 - 5.29)
	1-2 h/d	1.17	(0.65 - 2.12)	3.30	(1.05 - 10,38)
	>2 h/d	1.22	(0.64 - 2.35)	3.94	(1.23 - 12.59)
Trunk twisted & bent > 40°	never	1.0 (-)		1.0 (-)	
	<0.5 h/d	0.99	(0.59 - 1.66)	1.48	(0.39 - 5.67)
	0.5-2 h/d	1.79	(1.01 - 3.22)	3.93	(1.39 - 11.11)
	>2 h/d	1.07	(0.42 - 2.72)	3.65	(0.71- 18.76)
Lifting loads >15 kg	never	1.0 (-)		1.0 (-)	
	1-15 min/d	1.97	(1.24- 3.12)	2.92	(0.77 - 11.09)
	15-45 min/d	2.69	(1.50 - 4.84)	2.35	(0.51 -10.86)
	> 45 min/d	1.03	(0.51 - 2.07)	5.79	(1.20 -27.96)
Back bent forward or twisted while driving	never	1.0 (-)		1.0 (-)	
	seldom	1.12	(0.72 - 1.74)	1.11	(0.40 - 3.08)
	often	0.93	(0.58 - 1.50)	0.96	(0.31 - 2.98)
Physical load index (grade)	mild	1.0 (-)		1.0 (-)	
	moderate	1.07	(0.54 - 2.09)	0.87	(0.10 - 7.74)
	hard	2.09	(1.03 - 4.22)	2.90	(0.36 - 23.36)
	very hard	2.13	(0.83 - 5.48)	0.87	(0.56 - 50.51)

The results of a comparison of the assessment of the physical load, tasks and postures by real time observation (PalmTrac) with the questionnaire data in a sub sample of ten drivers of wheeled loaders revealed that the time spent ‘walking + standing’ and ‘bending’ was underestimated by half or more than half of the drivers. However, the time spent on ‘lifting’ was overestimated by 6 out of 10 of the drivers (Table 10).

Table 10. Comparison between the total time spent on different tasks and postures as recorded by PalmTrac assessment and by answers from the questionnaire (Q) in 10 drivers of wheeled loaders[16].

Task / posture	**Underestimation in total time: PalmTrac > Q**	**Total time PalmTrac = estimated time by Q**	**Overestimation in total time: PalmTrac < Q**
Walking and standing	6	2	2
Trunk bending	5	3	2
Sitting	0	10	0
Sitting (twisted / leaning forward)	3	4	3
Lifting	0	4	6

3.3 Evidence on strategies to reduce WBV exposure of drivers

A total of 1883 articles were retrieved from our literature search of the four databases. We identified 759 duplicates among the databases, leaving 1124 articles. Applying the eligibility inclusion criteria to titles and abstracts eliminated 620 articles. We then applied the selection criteria to the remaining titles with abstracts. This resulted in identifying 46 appropriate articles. The snowball method resulted in eleven extra hits from which the full text was read. Because our goal was primarily to explore which intervention measures were successful in reducing exposure to WBV, we did not apply any further methodological criteria in the selection. We read the full text of the remaining 57 articles. In total, 20 articles were excluded because five of them did not include any WBV measurements (25%), five were not available (25%), four did not show any values for exposure reduction (20%), five were neither field nor laboratory studies (25%), and one was too limited in its methods (5%). Thirty-five articles remained after applying the inclusion and selection criteria on the full text. These articles included 19 laboratory studies (Table 11), 21 field studies (Table 12), and only one intervention study. Almost all included studies presented one or more factors that had a significant or positive effect on reduction of vibration exposure. While most of the studies concentrated on factors dealing with design considerations (e.g. type of seat or cabin suspension) , the results of the review show that significant reduction of exposure can also be achieved by factors concerning 'skills and behaviour' (e.g. speed or driving experience)[17].

Table 11. Different outcome measures for an effective reduction of WBV exposure intensity, WBV exposure duration, or number of intervals of exposure in time, *results from laboratory studies*, * = significant effect, + = positive effect (i.e. exposure reduction), **-** = no effect, +/- = no consisted result and x = not measured. arms(m/s2) = RMS accelerations in m/s2, VDV = vibration dose value in $m/s^{1.75}$, SEAT = seat effective transmissibility factor; (ratio between a floor / a seat), STHT = seat to head transmissibility; (ratio between a seat/ a head), Acceleration response = PSD in $(m/s^2)^2/Hz$), fatigue decreased proficiency boundary = FDP in hrs, Exposure limit = according to ISO 2631;1980/2002, MTVV = maximum transient vibration value in m/s^2

Factors	Outcome measure	Evidence for successful reduction in exposure	Exposure		
			Intensity	Duration	Number of intervals in time
Design considerations					
Type of seat	a_{rms} (m/s^2)	▪ Hinz et al., 2002	+*	x	x
	STHT	▪ Paddan & Griffin, 1998	+*	x	x
	SEAT	▪ Hinz et al., 2002	+*	x	x
		▪ Huston et al., 1999	+	x	x
		▪ Kolich et al., 2005	+*	x	x
	Internal load (Ns^2/m)	▪ Hinz et al., 2002	+	x	x
Seat suspension	SEAT	▪ Boileau & Rakheja, 1990	+/-	x	x
		▪ Burdorf & Swuste, 1993	+	x	x
		▪ Hostens & Ramon, 2003	+*	x	x
		▪ Wilder et al., 1994	+	x	x
	a_{rms} (m/s^2)	▪ Bouazara et al., 2004	+*	x	x
		▪ Deprez et al., 2005b	+*	x	x
		▪ Sankar & Afonso, 1993	+*	x	x
	VDV $(m/s^{-1.75})$	▪ Deprez et al., 2005	+*	x	x
		▪ Deprez et al., 2005b	+*	x	x
	Hours driving with respect to exposure limit (ISO)	▪ Patil & Palanichamy, 1998	x	+	x
Cabin suspension	a_{rms} (m/s^2)	▪ Hansson, 1995	+*	x	x
		▪ Hansson, 2002	+*	x	x
		▪ Patil & Palanichamy, 1985	+*	x	x
	Hours driving with respect to exposure limit (ISO)	▪ Patil & Palanichamy, 1985	-	+*	-
Skills and behavior					
Weight of driver	SEAT	▪ Burdorf & Swuste, 1993	+*	x	x
		▪ Huston et al., 1999	+*	x	x
Posture of driver	a_{rms} (m/s^2)	▪ Hinz et al., 2002	+*	x	x
		▪ Magnusson et al., 1993	+	x	x
		▪ Wilder et al. ,1994	+*	x	x
	SEAT	▪ Hinz et al., 2002	+*	x	x
	STHT	▪ Demec et al., 2002	+	x	x
		▪ Zimmerman & Cook, 1997	+*	x	x
	Inter load (Ns^2/m)	▪ Hinz et al., 2002	+*	x	x

Table 12. Different outcome measures for an effective reduction of WBV exposure intensity, WBV exposure duration, or number of intervals of exposure in time, *results from field studies*, * = significant effect, + = positive effect (i.e. exposure reduction), - = no effect, +/- = no consisted result, and x = not measured. arms (m/s2) = RMS accelerations in m/s2, VDV = vibration dose value in $m/s^{1.75}$, SEAT = seat effective transmissibility factor; (ratio between a floor / a seat), Acceleration response = PSD in $(m/s^2)^2/Hz$), fatigue decreased proficiency boundary = FDP in hrs, Exposure limi t= according to ISO 2631; 1980/2002, MTVV = maximum transient vibration value in m/s^2.

Factors	Outcome measure	Author	Exposure		
			Intensity	Duration	Number of intervals in time
Design considerations					
Type of seat	a_{rms} (m/s^2)	▪ Chen et al., 2003	+*	x	x
		▪ Johanning et al., 2002	+	x	x
		▪ Özkaya et al., 1996 ▪ Wijaya & Jonsson, 2003	- +	x x	x x
	SEAT	▪ Johanning et al., 2002	-	x	x
	VDV ($m/s^{-1.75}$)	▪ Wijaya & Jonsson, 2003	+	x	x
	MTVV (m/s^2)	▪ Wijaya & Jonsson, 2003	+	x	x
Seat suspension	a_{rms} (m/s^2)	▪ Antonnen & Niskanen, 1994	+/-	x	x
		▪ Boileau & Rakheja, 1990	+/-	x	x
		▪ Burdorf et al., 1993	-	x	x
		▪ Cann et al., 2004	-	x	x
		▪ Malchaire et al., 1995	+*	x	x
		▪ Nishiyama et al., 1998	+	x	x
		▪ Özkaya et al., 1996	+/-	x	x
		▪ Özkaya et al., 1997	+*	x	x
	SEAT	▪ Boileau & Rakheja, 1990	+/-	x	x
		▪ Burdorf et al., 1993	-	x	x
		▪ Johanning et al., 2002	-	x	x
		▪ Paddan & Griffin, 2002	+*	x	x
	Exposure limit	▪ Boileau & Rakheja, 1990	X	+	x
		▪ Nishiyama et al., 1998	X	+	x
	PSD ($(m/s^2)^2/Hz$)	▪ Sankar & Afonso, 1993	+*	x	x
Cabin suspension	a_{rms} (m/s^2)	▪ Lemerle et al., 2002	+*	x	x
	SEAT	▪ Lemerle et al., 2002	+*	x	x
Location of cabin	a_{rms} (m/s^2)	▪ Piette & Malchaire, 1992	+*	x	x
Type of vehicle	a_{rms} (m/s^2)	▪ Cann et al., 2004	+*	x	x
		▪ Chen et al., 2003	+*	x	x
		▪ Malchaire et al., 1995	+*	x	x
		▪ Özkaya et al., 1997	+*	x	x
		▪ Rehn et al., 2005	+*	x	x
	VDV ($m/s^{-1.75}$)	▪ Rehn et al., 2005	+*	x	x
	Exposure limit	▪ Özkaya et al., 1997	x	+	x
Type of tyre on vehicle	a_{rms} (m/s^2)	▪ Malchaire et al., 1995	-	x	x
Inflation of the tyres on vehicle	a_{rms} (m/s^2)	▪ Malchaire et al., 1995	+	x	x
	SEAT	▪ Sherwin et al., 2004	+*	x	x
	VDV ($m/s^{-1.75}$)	▪ Sherwin et al., 2004	+*	x	x
	Exposure limit	▪ Sherwin et al., 2004	+*	x	x
Load of vehicle	a_{rms} (m/s^2)	▪ Malchaire et al., 1995	+*	x	x
		▪ Nishiyama et al., 1998	+	x	x
		▪ Özkaya et al., 1994	-	x	x
		▪ Piette & Malchaire, 1992	-	x	x
		▪ Rehn et al., 2005	+*	x	x
Vehicle maintenance	a_{rms} (m/s^2)	▪ Özkaya et al., 1994	+	x	x
Skills and behavior					
Weight of driver	a_{rms} (m/s^2)	▪ Boileau & Rakheja, 1990	+/-	x	x
		▪ Chen et al., 2003	+*	x	x
		▪ Malchaire et al., 1995	+*	x	x
	SEAT	▪ Boileau & Rakheja, 1990	+/-	x	x
	FDP	▪ Boileau & Rakheja, 1990	x	+/-	x
Posture of driver	a_{rms} (m/s^2)	▪ Johanning et al., 2002	+	x	x
		▪ EL-Khatib et al., 1998	+*	x	x

	VDV ($m/s^{-1.75}$)	▪ Wijaya & Jonsson, 2003	+*	x	x
Experience of driver	a_{rms} (m/s^{2})	▪ Cann et al., 2004	-	x	x
		▪ Chen et al., 2003	+*	x	x
		▪ Özkaya et al., 1994	+	x	x
		▪ Rehn et al., 2005	+*	x	x
Speed	a_{rms} (m/s^{2})	▪ Antonnen & Niskanen, 1994	+	x	x
		▪ Chen et al., 2003	+*	x	x
		▪ Johanning et al., 2002	-	x	x
		▪ Malchaire et al., 1995	+*	x	x
		▪ Özkaya et al., 1994	+*	x	x
		▪ Piette & Malchaire, 1992	+	x	x
		▪ Rehn et al., 2005	-	x	x
		▪ Sorainen & Rytkonen, 1999	+	x	x
	SEAT	▪ Johanning et al., 2002	-	x	x
	VDV $m/s^{-1.75}$	▪ Hostens & Ramon, 2003	+*	x	x
	Time (hrs) to reach 15 VDV $m/s^{-1.75}$	▪ Hostens & Ramon, 2003	x	+*	x
	FDP	▪ Sorainen & Rytkonen, 1999	x	+	x
	MTVV (m/s^{2})	▪ Wijaya & Jonsson, 2003	+	x	x
Track condition	a_{rms} (m/s^{2})	▪ Antonnen & Niskanen, 1994	+	x	x
		▪ Cann et al., 2004	+*	x	x
		▪ Johanning et al., 2002	+	x	x
		▪ Malchaire et al., 1995	+*	x	x
		▪ Piette & Malchaire, 1992	+	x	x
		▪ Rehn et al., 2005	+*	x	x
	VDV $m/s^{-1.75}$	▪ Hostens & Ramon, 2003	+*	x	x

3.4 Intervention study

The results of both surveys and the literature review were used to design an intervention study in a sub sample of the study population (Figure 1). The aim of this study is to investigate whether the use of a specific intervention programme is effective in reducing drivers' exposure to WBV in the selected companies. For this, a randomised controlled trial is currently performed in employees exposed to WBV and their employers.

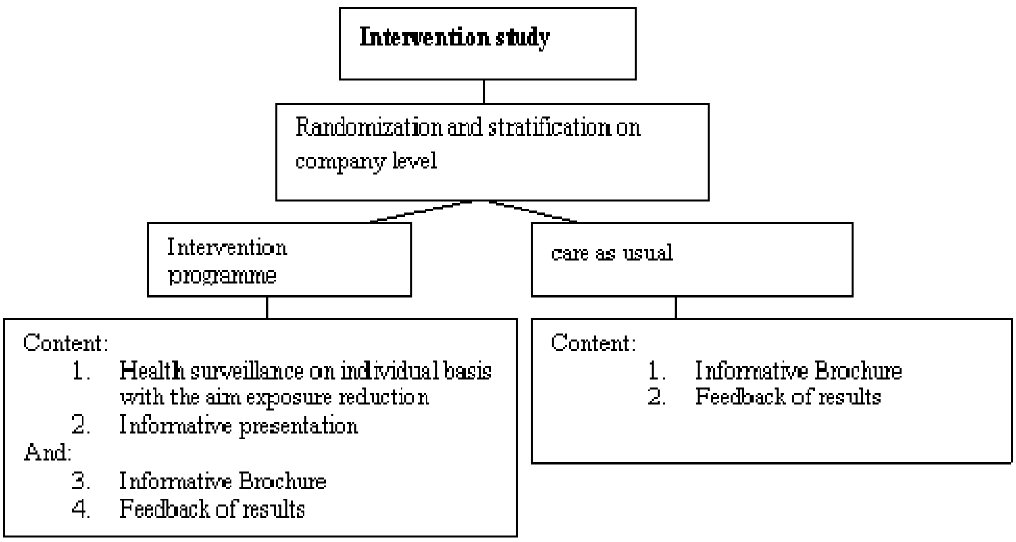


Figure 1 Design of the intervention study

The population is randomized over 2 groups on company level. One group receives a specific intervention programme and the other group “care as usual.” The intervention programme will predominantly have the aim to reduce vibration exposure to the employees. Both programmes consist of providing feedback on the vibration exposure values from the actual field measurements and, in addition to this, an information brochure is send to both groups. The difference between the two groups is that in the group which receives an intervention programme, (1) a health surveillance programme on individual basis and (2) an extra informative presentation will be carried out. Outcome and process parameters will be measured by a pre- and post intervention questionnaire and by field exposure measurements within both groups. The follow-up period time between the pre and post measurement will be 6-7 months. The study is currently going-on.

4 Discussion

In accordance with many earlier studies, the results of this prospective follow up study confirm that both the prevalence and the one year incidence of LBP (57.8 resp. 25.7%) in a cohort of drivers of various vehicles is relatively high compared to other occupational groups. Next to the health outcomes, also the WBV exposure data of our study are, in general, well in line with the majority of the comparable studies published in the last decade[3,5,8,13,18-20]. This gives an indication that still a substantial proportion of the driving workforce may be at risk for developing LBP.

The exposure estimation of a relatively low number of drivers in our study (11% in the baseline survey) exceeds the daily exposure action value $A(8)$ of 0.5 ms^{-2} r.m.s of the EU Directive when only the highest r.m.s. value of the dominant axis of vibration ($A_{dom}(8)$) is taken into account. In this study, we have estimated $A(8)$ using either the highest r.m.s. value of the dominant axis of vibration ($A_{dom}(8)$) or as the total (vectorsum) value a_v ($A_v(8)$) as the measure of frequency-weighted acceleration magnitude to be included in the analyses. These two values are significantly different, in particular in the (considerable) number of drivers of excavators, bulldozers, and lorries included in our study. If we take the total (vectorsum) value a_v ($A_v(8)$) into consideration then the number of drivers that would exceed the daily exposure action value $A(8)$ of 0.5 ms^{-2} r.m.s of the EU Directive would rise to 66% !

In this study, several physical and postural load factors, as assessed by responses to the questionnaire, were significant predictors of LBP. The reliability of this finding may, however, be disputed as comparison of the questionnaire responses with real time observation showed that the time spent in some unfavourable postures or tasks were underestimated while other were overestimated.

The multivariate data analysis showed that the currently recommended measures of daily vibration exposure, $A(8)$ or *VDV*, in general were poorly associated with most of the LBP outcomes, except for sick leave due to LBP. More significant relationships between the LBP outcomes and WBV exposure were seen when using the various cumulative dose measures, in particular for the occurrence of an episode of acute LBP in the previous 12 months. The results of the exposure-response analysis show, however, no consistency over the whole range of LBP outcomes. This may partly be explained by the fact that the drivers in the lowest reference quartile were also exposed to WBV. Besides, a few of the LBP outcomes suffered from low numbers in some categories, leading to wide confidence intervals. Pooling of the data of the different partners in this project, whenever possible, will therefore probably enable a further analysis with more statistical power.

5 Conclusion

This prospective cohort study tends to confirm that professional driving in industrial vehicles is associated with an increased risk of work-related LBP. Occupational exposure to WBV and physical loading factors at work are important components of the multifactorial origin of LBP in professional drivers. A clear exposure response pattern could not be derived from the results of this study but the pooling of the data of the different partners may give a more reliable picture. The combination of vibration measurements with real time observations at the workplace and a systematic review on measures of vibration reduction were of help in designing and tailoring a controlled intervention study that is still ongoing in a sub sample of the study population.

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Appendix: Tables of the multivariate and longitudinal analyses

Appendix Tables 1: multivariate analyses

Appendix Tables 2: longitudinal analyses

Tables 1. Multivariate analyses

Table 1. Distribution of the study populations investigated at both cross-sectional and follow-up survey (n=407) by industry and machinery in the Netherlands.

Company	**Number of drivers T0**	**Number of drivers T1**	**Machine/vehicle**
1	24	14	Lawn mowing machine
2	17	16	Mobile Crane Wheel loader Roadroller
3	46	40	Tractor Lawn mowing machines
4	28	17	Dumper Excavator Road roller
5	3	3	Wheel loader
6	47	-	Lorry
7	22	18	Wheel loader Dumper Bull dozer Excavator
8	5	4	Mobile crane
9	156	129	Lorry
10	11	11	Boat
11	7	6	Excavator Wheel loader
12	15	15	Wheel loader Dumper Bulldozer
13	193	193	Tractor Lawn mowing machines Excavator Dumper Road roller Asphalt machine

Table 2. Frequency-weighted root-mean-square (r.m.s.) acceleration magnitude (a_w) of vibration measured in the *x*-, *y*-, and *z*-directions on the seat of industrial machines and vehicles. The vibration total value of frequency-weighted r.m.s. accelerations (a_v) is calculated according to International Standard ISO 2631-1 (1997). Data are given as means (standard deviations).

Machine/vehicle	Company	Number of vehicles measured	Frequency-weighted acceleration magnitude			
			a_{wx} (ms^{-2} r.m.s.)	a_{wy} (ms^{-2} r.m.s.)	a_{wz} (ms^{-2} r.m.s.)	a_v (ms^{-2} r.m.s.)
Wheel loader	2	3	0.60 (0.14)	0.51 (0.10)	0.42 (0.08)	0.99 (0.20)
Wheel loader	5	2	0.45 (0.04)	0.32 (0.01)	0.29 (0.06)	0.69 (0.07)
Wheel loader	7	1	0.82 (-)	0.98 (-)	0.45 (-)	1.40 (-)
Wheel loader	11	1	0.70 (-)	0.73 (-)	0.56 (-)	1.28 (-)
Wheel loader	12	2	0.91 (0.27)	0.83 (0.16)	0.68 (0.13)	1.55(0.36)
Excavator	4	1	0.15 (-)	0.10 (-)	0.08 (-)	0.21 (-)
Excavator	7	1	0.27 (-)	0.19 (-)	0.31 (-)	0.86 (-)
Excavator	11	2	0.25 (0.03)	0.14 (0.02)	0.19 (0.06)	0.38 (0.17)
Excavator	13	1	0.28 (-)	0.13 (-)	0.17 (-)	0.39 (-)
Lawn mowing machine	1	2	0.49 (0.12)	0.59 (0.18)	0.48 (0.10)	1.01 (0.25)
Lawn mowing machine	3	5	0.57 (0.16)	0.53 (0.21)	0.49 (0.13)	1.05 (0.29)
Lawn mowing machine	13	2	0.57 (0.08)	0.6 (0.01)	0.49 (0.13)	1.08 (0.15)
Mobile crane	2	1	0.17 (-)	0.12 (-)	0.15 (-)	0.29 (-)
Mobile crane	8	2	0.11 (0.1)	0.12 (0.13)	0.22 (0.23)	0.34 (0.37)
Road roller	2	1	0.15 (-)	0.13 (-)	0.16 (-)	0.30 (-)
Road roller	13	1	0.14 (-)	0.17 (-)	0.15 (-)	0.31 (-)
Tractor	3	1	0.53 (-)	0.59 (-)	0.57 (-)	1.13 (-)
Tractor	13	2	0.29 (0.07)	0.34 (-)	0.16 (0.04)	0.50 (0.06)

Dumper	4	2	0.29 (0.10)	0.31 (0.05)	0.45 (0.21)	0.76 (0.29)
Dumper	7	1	0.44 (-)	0.33 (-)	0.54 (-)	0.94 (-)
Dumper	12	1	0.24 (-)	0.34 (-)	0.27 (-)	0.56 (-)
Dumper	13	1	0.17 (-)	0.16 (-)	0.39 (-)	0.59 (-)
Lorry	9	4	0.23 (0.04)	0.23 (0.01)	0.35 (0.05)	0.58 (0.06)
Boat	10	2	0.09 (0.05)	0.21 (0.17)	0.09 (0.07)	0.27 (0.18)
Bulldozer	7	1	0.38 (-)	0.31 (-)	0.50 (-)	0.86 (-)
Bulldozer	12	1	0.54 (-)	0.30 (-)	0.73 (-)	1.20 (-)
Asphalt machine	13	1	0.08 (-)	0.09 (-)	0.06 (-)	0.15 (-)

Table 3. Characteristics of the study populations at the cross-sectional survey. Data are given as means (standard deviations) for age and anthropometric characteristics, or as numbers (%) for smoking, drinking, marital status, education and physical activity

	Driver groups in the different companies					
	1 (n=11)	2 (n=10)	3 (n=25)	4 (n=13)	5 (n=2)	6 (n=24)
Age (yr)	43.8 (12.3)	43.0 (13.0)	42.3 (11.4)	52.3 (10.3)	36.2 (4.1)	42.6 (10.2)
Height (cm)	182 (7.3)	178 (8.3)	184 (7.7)	176 (7.8)	186 (5.7)	182 (6.4)
Weight (kg)	90.3 (19.3)	89.6 (11.6)	84.8 (15.2)	85.4 (14.0)	98.5 (9.2)	87.8 (13.8)
Body mass index (kg/m^2)	27.3 (5.1)	28.4 (3.5)	25.1 (3.7)	27.5 (4.3)	28.4 (0.9)	26.5 (4.5)
Smoking (n): never	6 (54.5)	3 (30)	9 (36.0)	4 (30.8)	2 (100.0)	5 (20.8)
ex-smokers	2 (18.2)	6 (60)	7 (28.0)	5 (38.5)	-	9 (37.5)
current smokers	3 (27.3)	1 (10)	9 (36.0)	4 (30.8)	-	10 (41.7)
Drinking (n)	8 (72.7)	6 (60)	24 (96.0)	10 (76.9)	2 (100.0)	22 (91.7)
Married (n)	10 (90.9)	9 (90)	21 (84.0)	12 (92.3)	2 (100.0)	22 (91.7)
Physical activity (n): never	2 (18.2)	1(10)	3 (12.0)	3 (23.1)	-	4 (16.7)
1-2 per week	-	1 (10)	3 (12.0)	1 (7.7)	2 (100.0)	6 (25.0)
3-4 per week	1 (9.1)	3 (30)	6 (24.0)	4 (30.8)	-	3 (12.5)
> 4 per week	8 (72.7)	5 (50)	13 (54.0)	5 (38.5)	-	11 (45.8)

	7 (n=13)	8 (n=5)	9 (n=57)	10 (n=11)	11 (n=6)	12 (n=13)	13 (n=128)
Age (yr)	45.2 (11.1)	37.6 (11.9)	42.9 (10.5)	52.3 (5.9)	40.8 (17.0)	45.7 (10.6)	45.0 (9.9)[b]
Height (cm)	180 (4.0)	183 (4.3)	184 (8.5)	178 (8.0)	182 (5.4)	183 (7.6)	181 (6.8)[b]
Weight (kg)	89.8 (7.2)	87.8 (2.4)	87.4 (11.4)	84.5 (13.7)	90.7 (14.0)	87.8 (11.8)	87.9 (12.2)[a]
Body mass index (kg/m^2)	27.9 (2.6)	26.4 (1.6)	26.0 (3.4)	26.7 (3.6)	27.4 (4.2)	26.2 (2.5)	26.8 (3.4)[b]
Smoking (n): never	7 (53.8)	1 (20.0)	18 (3.6)	1 (9.1)	2 (33.3)	2 (15.4)	41 (32.0)[d]
ex-smokers	3 (23.1)	2 (40.0)	13 (22.8)	5 (45.4)	1 (16.7)	6 (46.2)	38 (29.7)
current smokers	3 (23.1)	2 (40.0)	26 (45.6)	5 (45.4)	3 (50.0)	5 (38.2)	49 (38.3)[d]
Drinking (n)	10 (76.9)	3 (60.0)	49 (86.3)	11 (100.0)	3 (50.0)	13 (100.0)	102 (79.7)[d]
Married (n)	11 (84.6)	5 (100.0)	49 (86.3)	9 (81.8)	5 (83.3)	13 (100.0)	113 (88.3)[d]
Physical activity (n): never	4 (30.8)	2 (20.0)	13 (22.8)	1 (9.1)	3 (50.0)	3 (23.1)	28 (21.9)
1-2 per week	6 (46.2)	1 (10.0)	5 (8.8)	1 (9.1)	-	7 (53.8)	40 (31.3)
3-4 per week	2 (15.4)	2 (20.0)	9 (15.8)	3 (27.3)	-	2 (15.4)	20 (15.6)
> 4 per week	1 (7.7)	5 (50.0)	30 (52.6)	6 (54.5)	3 (50.0)	1 (7.7)	40 (31.3)

F test (one-way ANOVA): [a]$p<0.05$; [b]$p<0.01$
Chi-square test: [c]$p<0.05$; [d]$p<0.01$

Table 4a. Measures of daily exposure to whole-body vibration (WBV) in the professional drivers at the cross-sectional survey (see text for definitions of WBV exposure). Data are given as means (standard deviations) or *medians (quartiles)*. Previous jobs with WBV exposure are given as numbers (%).

Measures of daily vibration exposure	Driver groups in the different companies					
	1 (n=11)	2 (n=10)	3 (n=25)	4 (n=13)	5 (n=2)	6 (n=24)
Daily driving time (h)	3.3 (1.5) *3.0 (2.0-4.0)*	6.2 (2.6) *7.6 (3.5-8.0)*	6.9 (3.6) *8.0 (3.3-9.1)*	7.6 (3.1) *8.0 (6.1-9.8)*	9.5 (0.7) *9.5 (9.0-10.0)*	9.5 (1.9) *10 (8.0-10.8)*
$A_v(8)$ (ms^{-2} r.m.s.)	0.42 (0.17) *0.35 (0.28-0.61)*	0.66 (0.34) *0.67 (0.37-0.82)*	0.82 (0.38) *0.68 (0.55-1.14)*	0.54 (0.20) *0.58 (0.46-0.68)*	1.20 (0.07) *1.20 (1.15-1.25)*	0.57 (0.05) *0.58 (0.58-0.58)*
$A_{dom}(8)$ (ms^{-2} r.m.s.)	0.3 (0.1) *0.2 (0.2- 0.4)*	0.5 (0.2) *0.5 (0.3-0.6)*	0.6 (0.2) *0.5 (0.4- 0.8)*	0.4 (0.2) *0.4 (0.3- 0.5)*	0.8 (0.1) *0.8 (0.7- 0.8)*	0.4 (0.0) *0.4 (0.4- 0.4)*
VDV_v ($ms^{-1.75}$)	6.0 (3.0) *4.5 (3.7-9.2)*	7.1 (2.8) *6.5 (5.2-8.3)*	11.4 (4.7) *10.2 (8.3-14.6)*	7.3 (3.8) *6.5 (5.2-9.8)*	12.9 (3.1) *12.9 (10.8-15.1)*	6.1 (1.2) *5.6 (5.6-5.6)*
VDV_{dom} ($ms^{-1.75}$)	5.1 (2.6) *4.0 (3.2-7.3)*	6.4 (2.5) *5.8 (4.7-7.4)*	9.9 (3.9) *9.7 (7.4-12.4)*	6.6 (3.5) *5.8 (4.7-8.6)*	10.7 (2.8) *10.7 (8.8-12.7)*	5.5 (1.2) *5.1 (5.1-5.1)*
Previous jobs with WBV exposure (n)	10 (90.9)	6 (60.0)	22 (88.0)	10 (76.9)	1 (50.0)	20 (83.3)

Measures of daily vibration exposure	Driver groups						
	7 (n=13)	8 (n=5)	9 (n=57)	10 (n=11)	11 (n=6)	12 (n=13)	13 (n=128)
Daily driving time (h)	8.4 (2.8) *9.0 (8.0- 10.0)*	5.6 (3.5) *4.2 (2.6-9.2)*	8.2 (2.9) *8.6 (6.1-10.4)*	6.5 (1.9) *7.2 (4.8-8.0)*	7.5 (0.8) *8.0 (6.7-8.0)*	9.1 (1.5) *8.4 (8.0-10.0)*	8.4 (1.8) *8.2 (8.0-9.6)*[a]
$A_v(8)$ (ms^{-2} r.m.s.)	0.64 (0.24) *0.58 (0.53-0.68)*	0.30 (0.23) *0.34 (0.07-0.51)*	0.54 (0.1) *0.58 (0.51-0.58)*	0.3 (0.1) *0.28 (0.27-0.30)*	0.84 (0.39) *0.63 (0.56-1.32)*	0.78 (0.32) *0.68 (0.56-0.98)*	0.5 (0.3) *0.5 (0.4-0.7)* [a]
$A_{dom}(8)$ (ms^{-2} r.m.s.)	0.5 (0.2) *0.4 (0.4- 0.5)*	0.2 (0.2) *0.2 (0.0- 0.3)*	0.4 (0.1) *0.4 (0.3- 0.4)*	0,2 (0,0) *0.2 (0.2-0.2)*	0.6 (0.2) *0.5(0.4-0.9)*	0.5 (0.2) *0.5 (0.4- 0.7)*	0.4 (0.2) *0.7 (0.6-1.0)* [a]
VDV_v ($ms^{-1.75}$)	7.9 (2.6) *8.8 (5.8-9.4)*	4.8 (4.1) *4.6 (0.8-8.9)*	6.4 (2.2) *5.6 (5.5-6.0)*	3.9 (1.5) *2.8 (2.8-4.9)*	8.2 (3.6) *6.2 (5.5-12.6)*	8.2 (3.1) *7.6 (5.8-10.5)*	6.2 (3.2) *7.6 (5.8-10.5)* [a]
VDV_{dom} ($ms^{-1.75}$)	7.1 (2.4) *7.8 (5.2-8.3)*	4.4 (3.8) *4.1(0.7-8.2)*	5.8 (2.1) *5.1 (4.9-5.4)*	3.6 (1.3) *2.7 (2.6-4.5)*	7.1 (2.7) 5.6 (5.1-10.4)	7.1 (2.5) *6.7 (5.1-9.3)*	5.4 (2.8) *6.7 (5.1-9.3)* [a]
Previous jobs with WBV exposure (n)	9 (69.2)	3 (60.0)	49 (86.0)	5 (45.5)	3 (50.0)	9 (69.2)	71 (61.7)[b]

Kruskall-Wallis one-way analysis of variance: [a]$p<0.001$; chi-square test: [b]$p<0.01$

Table 4b. Measures of cumulative (lifetime) exposure to whole-body vibration (WBV) in the professional drivers at the cross-sectional survey (see text for definitions of cumulative WBV exposure). Data are given as means (standard deviations) or *medians (quartiles)*.

Measures of cumulative WBV exposure	Driver groups in the different companies					
	1 (n=11)	2 (n=10)	3 (n=25)	4 (n=13)	5 (n=2)	6 (n=24)
Duration of exposure (yr)	12,0 (10.5) *10.9 (2.1- 20.4)*	20,5 (12.8) *19.4 (10.4-32.6)*	13,0 (11.5) *7.4 (4.0- 21.0)*	28,7 (11.5) *33.0 (17.7-37.5)*	15,7 (7.1) *15.7 (10.7-20.7)*	10,1 (10.8) *5.7 (1.8- 15.6)*
$\Sigma[t_i]$ (h $\times 10^3$)	6,6 (5.8) *4.1 (1.6- 11.2)*	25,7 (20.6) *20.8 (5.0- 43.4)*	20,2 (23.1) *10.2 (4.3- 35.8)*	43,9 (28.2) *50.0 (18.0-64.5)*	29,3 (11.2) *29.3 (21.4- 37.3)*	20,0 (22.3) *11.0 (3.4- 35.9)*
$\Sigma[a_{wsi}t_i]$ ($ms^{-2}h \times 10^3$)	4,6 (4.7) *2.3 (1.5- 6.8)*	20,6 (17.3) *19.7 (3.3- 35.3)*	16,2 (17.2) *7.6 (4.1-27.9)*	25,6 (17.7) *25.6 (10.4-37.0)*	35,2 (14.9) *35.2 (24.6- 45.7)*	11,6 (12.9) *6.1 (2.0- 20.8)*
$\Sigma[a_{wsi}^2t_i]$ ($m^2s^{-4}h \times 10^3$)	3,6 (5.1) *1.3 (1.2- 4.6)*	18,2 (19.1) *14.3 (2.2- 28.6)*	15,6 (20.2) *7.1 (4.3-22.1)*	16,1 (11.9) *17.3 (5.2- 25.6)*	43,3 (21.2) *43.3 (28.3- 58.3)*	6,7 (7.5) *3.4 (1.1- 12.0)*
$\Sigma[a_{wsi}^4t_i]$ ($m^4s^{-8}h \times 10^3$)	3,0 (7.2) *0.5 (0.4- 2.1)*	18,7 (30.8) *6.6 (1.0- 22.8)*	23,2 (46.8) *9.5 (2.5- 24.7)*	6,8 (5.5) *8.1 (1.7-10.9)*	68,0 (43.2) *68.0 (37.5- 98.6)*	2,2 (2.5) *1.2 (0.4- 4.0)*
$\Sigma[a_{wqi}t_i]$ ($ms^{-2}h \times 10^3$)	3.0 (3.3) *1.7 (1.0-4.9)*	15.1 (12.6) *14.7 (2.5-25.8)*	12.0 (12.8) *5.6 (3.0-2.3)*	19.1 (13.1) *18.9 (7.7-28.1)*	25.5 (11.0) *25.5 (17.7-33.3)*	8.6 (9.7) *4.5 (1.5-15.5)*
$\Sigma[a_{wq}{}^2{}_it_i]$ ($m^2s^{-4}h \times 10^3$)	1.8 (2.8) *0.7 (0.6-2.2)*	9.8 (10.1) *7.6 (1.2-15.6)*	8.5 (12.8) *3.9 (2.4-12.5)*	8.9 (6.6) *9.4 (2.9-11.8)*	22.7 (11.4) *22.7 (14.6-30.8)*	3.7 (4.2) *1.9 (0.6-6.7)*
$\Sigma[a_{wqi}^4t_i]$ ($m^4s^{-8}h \times 10^3$)	0.9 (2.1) *0.1 (0.1-0.4)*	5.5 (8.8) *1.9 (0.3-7.0)*	6.7 (13.4) *2.8 (0.8-7.1)*	2.1 (1.8) *2.3 (0.5-3.3)*	18.7 (12.4) *18.7 (10.0-27.5)*	0.7 (0.8) *0.4 (0.1-1.3)*

Measures of cumulative WBV exposure	Driver groups in the different companies						
	7 (n=13)	8 (n=5)	9 (n=57)	10 (n=11)	11 (n=6)	12 (n=13)	13 (n=128)
Duration of exposure (yr)	15,3 (10.3) *11.0 (9.3- 21.6)*	13,3 (13.3) *7.9 (4.5- 24.9)*	12,6 (11.2) *8.1 (3.8- 17.3)*	29,1(8,8) *31.7 (24.0-35.1)*	15,7 (13.9) 10.0 (4.7- 29.4)	20,4 (11.2) *17.5 (10.6- 30.7)*	19,8 (11.7) *17.8 (9.2- 30.4)*[a]
$\sum[t_i]$ (h $\times 10^3$)	24,4 (17.1) *19.9 (14.2- 27.0)*	15,2 (13.7) *12.6 (2.3- 29.4)*	21,9 (24.6) *11.9 (4.7- 27.2)*	36,9 (13,8) *42.0 (23.0-47.6)*	23,7 (21.9) 14.3 (7.5- 43.1)	37,5 (22.6) *34.9 (18.8- 54.0)*	33.6 (20.7) *33.0 (15.4-49.8)* [a]
$\sum[a_{wsi}t_i]$ ($ms^{-2}h \times 10^3$)	16,2 (11.3) *12.8 (8.1- 23.2)*	7,5 (9.1) *1.3 (0.6-17.4)*	13,1 (15.6) *6.9 (2.8- 16.4)*	11,7 (3.7) *12.7 (10.0- 14.1))*	26,7 (32.7) 8.3 (4.6- 60.5)	27,5 (15.5) *24.6 (16.9- 41.3)*	18.5 (15.1) *15.0 (6.4-29.2)* [a]
$\sum[a_{wsi}^2 t_i]$ ($m^2s^{-4}h \times 10^3$)	11,7 (10.6) *7.5 (4.8- 16.5)*	4,4 (5.5) *0.9 (0.1-10.4)*	8,0 (10.2) *4.1 (1.7- 9.7)*	4,2 (2,1) *3.7 (3.0- 5.3)*	33,3 (46.6) 4.9 (3.0- 85.1)	22,6 (16.4) 19.2 (9.8- 34.8)	11.6 (17.1) *6.4 (2.2-14.2)* [a]
$\sum[a_{wsi}^4 t_i]$ ($m^4s^{-8}h \times 10^3$)	9,0 (19.3) *2.8 (2.1- 6.3)*	1,6 (2.1) *0.4 (0.0- 3.9)*	3,2 (5.2) *1.6 (0.6- 3.4)*	0,8 (0,9) *0.3 (0.3-1.2)*	59,0 (89.4) 1.8 (1.3- 169.4)	24,3 (40.9) *8.8 (2.9- 25.4)*	8.7 (28.1) *1.6 (0.5-6.3)* [a]
$\sum[a_{wqi}t_i]$ ($ms^{-2}h \times 10^3$)	12.0 (8.4) *9.4 (6.1-17.3)*	5.6 (6.8) *1.0 (0.5-13.0)*	9.9 (11.8) *5.1 (2.1-12.3)*	8.9 (2.7) *9.7 (7.6-10.8)*	19.5 (23.7) *6.3 (3.4-43.6)*	19.9 (11.7) *17.8 (10.2-30.3)*	13.0 (11.3) *17.8 (10.2-30.3)* [a]
$\sum[a_{wq}{}^2{}_i t_i]$ ($m^2s^{-4}h \times 10^3$)	6.4 (6.0) *4.0 (2.5-8.9)*	2.5 (3.1) *0.5 (0.0-5.9)*	4.5 (5.9) *2.4 (1.0-5.5)*	2.3 (1.1) *2.1 (1.7-2.9)*	17.5 (24.3) *2.8 (1.6-44.2)*	12.1 (9.0) *10.3 (4.5-18.9)*	6.3 (9.0) *10.3 (4.5-18.9)* [a]
$\sum[a_{wqi}^4 t_i]$ ($m^4s^{-8}h \times 10^3$)	2.8 (6.4) *0.9 (0.6-1.8)*	0.5 (0.7) *0.1 (0.0-1.3)*	1.1 (1.8) *0.5 (0.2-1.1)*	0.2 (0.2) *0.1 (0.1-0.3)*	16.1 (24.4) *0.6 (0.4-45.6)*	7.0 (11.8) *2.5 (0.8-7.4)*	2.5 (7.8) *2.5 (0.8-7.4)* [a]

Table 5. Prevalence and one-year incidence of low back pain (LBP) symptoms in the total sample of professional drivers (n=230).

Outcome	Prevalence (%)	Incidence (%)
LBP in the previous 7 days	32.6	18.2 (n=42)
LBP in the previous 12 months	57.8	25.7 (n=59)
Episodes of acute LBP in the previous 12 months	36.5	9.1 (n=21)
Episodes of sciatica in the previous 12 months	21.7	10.4 (n=24)
Duration of LBP > 30 d/yr in the previous 12 months	12.3	7.8 (n=18)
High pain intensity in the lower back in the previous 7 days (Von Korf pain scale score > 5)	8.3	5.6 (n=13)
Disability due to the last episode of LBP (Roland & Morris disability scale score ≥ 12)	5.7	1.7 (n=4)
Visit to a doctor for LBP in the previous 12 months	20.4	7.8 (n=18)
LBP treated with medication and/or physical therapy In the previous 12 months	21.3	6.5 (n=15)
Sick leave > 2 days due to LBP in the previous 12 months Sick leave > 7 days due to LBP in the previous 12 months	13.0 8.7	5.6 (n=13) 5.2 (n=12)
Back trauma	8.3	3.1 (n=10)

Table 6a. Binary logistic regression for the association between low back pain (LBP) symptoms (7-day LBP, 12-month LBP, high pain intensity in the lower back (Von Korff pain scale score > 5) during the previous 12 months, disability (Roland & Morris disability scale score ≥ 12) during the last episode of LBP) and various individual and work-related risk factors in the professional drivers (n=230) over one-year follow-up period. Odds ratios (OR) and 95% confidence intervals (95% CI) are adjusted by age and follow-up time.

Factors		7-day LBP		12-month LBP		High pain intensity		LBP disability	
		OR (95% CI)		OR (95% CI)		OR (95% CI)		OR (95% CI)	
Age (yr)	≤35	1.0 (-)		1.0 (-)		1.0 (-)		1.0 (-)	
	36-41	1,105	,555 2,198	1,548	,758 3,161	,450	,082 2,467	3,344	,282 39,688
	42-48	,950	,520 1,734	1,199	,661 2,177	1,313	,387 4,452	6,265	,683 57,432
	>48	,958	,576 1,593	,678	,413 1,112	2,437	,892 6,659	7,276	,905 58,503
BMI (kg/m^2)	<25	1.0 (-)		1.0 (-)		1.0 (-)		1.0 (-)	
	25-27	1,172	,692 1,984	1,010	,604 1,687	,720	,261 1,983	,504	,125 2,023
	>27	1,201	,752 1,917	,950	,603 1,496	,897	,373 2,153	,927	,303 2,834
Smoking	no smoking	1.0 (-)		1.0 (-)		1.0 (-)		1.0 (-)	
	ex-smoker	1,088	,662 1,786	1,465	,909 2,363	1,477	,559 3,902	,470	,125 1,763
	current smoker	1,436	,910 2,265	1,321	,845 2,065	2,156	,888 5,237	1,089	,376 3,156
Drinking (unit/week)	0	1.0 (-)		1.0 (-)		1.0 (-)		1.0 (-)	
	1-3	1,188	,647 2,182	1,210	,675 2,169	,940	,279 3,165	,734	,160 3,370
	4-6	,885	,474 1,652	,816	,457 1,455	1,612	,487 5,333	1,083	,248 4,728
	>6	1,496	,852 2,626	1,354	,785 2,335	1,344	,454 3,974	,840	,221 3,193
Married	no	1.0 (-)		1.0 (-)		1.0 (-)		1.0 (-)	
	yes	1,589	,821 3,074	2,110	1,146 3,882	1,410	,402 4,952	1,161	,128 10,541
Previous jobs with WBV exposure	no	1.0 (-)		1.0 (-)		1.0 (-)		1.0 (-)	
	yes	1,166	,794 1,714	1,288	,885 1,875	,834	,437 1,591	,466	,184 1,184
Previous job with heavy physical load	no	1.0 (-)		1.0 (-)		1.0 (-)		1.0 (-)	
	yes	1,853	1,254 2,737	1,361	,926 1,998	1,170	,611 2,241	,734	,289 1,864
Sitting > 3h at work	no	1.0 (-)		1.0 (-)		1.0 (-)		1.0 (-)	
	yes	1,009	,683 1,490	,988	,676 1,445	,689	,355 1,338	,832	,321 2,158
Trunk bent at work	no	1.0 (-)		1.0 (-)		1.0 (-)		1.0 (-)	
	yes	1,408	,936 2,117	1,794	1,184 2,718	2,286	1,186 4,408	1,946	,751 5,046
Trunk twisted at work	no	1.0 (-)		1.0 (-)		1.0 (-)		1.0 (-)	
	yes	1,308	,876 1,953	1,198	,806 1,779	3,050	1,569 5,931	2,184	,841 5,666
Lifting at work	no	1.0 (-)		1.0 (-)		1.0 (-)		1.0 (-)	
	yes	1,950	1,309 2,905	1,794	1,204 2,672	4,374	2,177 8,791	2,514	,928 6,813
Lifting & bending at work	no	1.0 (-)		1.0 (-)		1.0 (-)		1.0 (-)	
	yes	1,910	1,283 2,842	1,731	1,184 2,530	3,968	1,779 8,851	2,583	,809 8,247
Lifting & twisting at work	no	1.0 (-)		1.0 (-)		1.0 (-)		1.0 (-)	
	yes	2,149	1,434 3,221	1,500	1,000 2,249	4,431	2,222 8,837	2,719	1,007 7,339
Back bent forward or twisted while driving	no	1.0 (-)		1.0 (-)		1.0 (-)		1.0 (-)	
	yes	1,190	,804 1,759	1,017	,696 1,486	,818	,429 1,561	,893	,340 2,350

Table 6b. Binary logistic regression for the association between low back pain (LBP) symptoms in the previous 12 months (acute LBP, sciatica, treated LBP, sick leave due to LBP) various individual and work-related risk factors in the professional drivers (n=230) over one-year follow-up period. Odds ratios (OR) and 95% confidence intervals (95% CI) are adjusted by age and follow-up time.

Factors		Acute LBP		Sciatica		Treated LBP		Sick leave (>7 days)	
		OR (95% CI)		OR (95% CI)		OR (95% CI)		OR (95% CI)	
Age (yr)	≤35	1.0 (-)		1.0 (-)		1.0 (-)		1.0 (-)	
	36-41	1,998	1,017 3,924	2,156	,878 5,295	1,453	,561 3,764	1,285	,276 5,972
	42-48	1,052	,579 1,913	2,308	1,048 5,085	2,185	,986 4,840	2,708	,817 8,979
	>48	,732	,436 1,228	2,458	1,219 4,956	2,003	,984 4,076	1,960	,640 6,000
BMI (kg/m^2)	<25	1.0 (-)		1.0 (-)		1.0 (-)		1.0 (-)	
	25-27	1,131	,671 1,906	,800	,397 1,615	,844	,444 1,601	1,154	,447 2,983
	>27	,932	,583 1,489	2,161	1,234 3,787	,907	,517 1,592	1,054	,444 2,502
Smoking	no smoking	1.0 (-)		1.0 (-)		1.0 (-)		1.0 (-)	
	ex-smoker	2,029	1,222 3,368	1,160	,662 2,034	1,447	,793 2,638	2,037	,802 5,174
	current smoker	1,810	1,129 2,904	1,059	,615 1,825	1,401	,787 2,492	1,872	,752 4,658
Drinking (unit/week)	0	1.0 (-)		1.0 (-)		1.0 (-)		1.0 (-)	
	1-3	1,318	,723 2,403	,717	,360 1,430	,629	,298 1,327	,606	,157 2,337
	4-6	,822	,441 1,534	,681	,339 1,367	,823	,402 1,684	1,777	,591 5,345
	>6	1,099	,623 1,937	,882	,473 1,643	,920	,479 1,767	1,536	,532 4,435
Married	no	1.0 (-)		1.0 (-)		1.0 (-)		1.0 (-)	
	yes	1,993	1,018 3,902	1,703	,721 4,022	1,020	,459 2,264	1,226	,342 4,393
Previous jobs with WBV exposure	no	1.0 (-)		1.0 (-)		1.0 (-)		1.0 (-)	
	yes	1,361	,922 2,010	,975	,622 1,527	,738	,460 1,186	,861	,427 1,738
Previous job with heavy physical load	no	1.0 (-)		1.0 (-)		1.0 (-)		1.0 (-)	
	yes	2,028	1,367 3,009	1,399	,890 2,199	1,004	,622 1,621	1,954	,963 3,965
Sitting > 3h at work	no	1.0 (-)		1.0 (-)		1.0 (-)		1.0 (-)	
	yes	1,092	,737 1,619	,844	,534 1,333	1,063	,659 1,714	,530	,252 1,113
Trunk bent at work	no	1.0 (-)		1.0 (-)		1.0 (-)		1.0 (-)	
	yes	1,824	1,212 2,745	1,908	1,194 3,051	1,404	,857 2,298	1,997	,979 4,074
Trunk twisted at work	no	1.0 (-)		1.0 (-)		1.0 (-)		1.0 (-)	
	yes	1,475	,987 2,206	1,855	1,167 2,948	1,402	,863 2,276	2,214	1,088 4,505
Lifting at work	no	1.0 (-)		1.0 (-)		1.0 (-)		1.0 (-)	
	yes	1,987	1,332 2,964	2,063	1,300 3,273	2,147	1,327 3,475	2,591	1,262 5,320
Lifting & bending at work	no	1.0 (-)		1.0 (-)		1.0 (-)		1.0 (-)	
	yes	2,137	1,428 3,195	2,458	1,519 3,978	2,243	1,357 3,708	2,660	1,208 5,861
Lifting & twisting at work	no	1.0 (-)		1.0 (-)		1.0 (-)		1.0 (-)	
	yes	2,506	1,669 3,764	2,428	1,526 3,864	2,501	1,537 4,071	3,160	1,540 6,487
Back bent forward or twisted while driving	no	1.0 (-)		1.0 (-)		1.0 (-)		1.0 (-)	
	yes	1,086	,732 1,611	,805	,512 1,264	1,533	,936 2,510	1,598	,752 3,396

Table 7a. Binary logistic regression for the association between low back pain (LBP) symptoms in the previous 12 months (acute LBP, sciatica, treated LBP, sick leave due to LBP) and various individual and work-related risk factors in the professional drivers (n=230) over one-year follow-up period. Odds ratios (OR) and 95% confidence intervals (95% CI) are adjusted by age and follow-up time..

Factor	7-day LBP	12-month LBP	High pain intensity	LBP disability
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Job satisfaction in general:				
very satisfied	1.0 (-)	1.0 (-)	1.0 (-)	1.0 (-)
very dissatisfied	,000 ,000	,000 ,000	,000 ,000	,000 ,000
dissatisfied	5,662 ,564 56,812	2,220 ,222 22,239	2,880 ,269 30,820	13,857 ,949 202,357
not satisfied/not dissatisfied	,783 ,352 1,745	,956 ,451 2,028	,897 ,256 3,151	2,951 ,465 18,740
satisfied	1,017 ,625 1,654	1,066 ,663 1,716	,797 ,357 1,779	1,983 ,440 8,933
Content of work:				
very satisfied	1.0 (-)	1.0 (-)	1.0 (-)	1.0 (-)
very dissatisfied	-	-	-	-
dissatisfied	1,629 ,377 7,031	,726 ,166 3,171	3,662 ,408 32,868	4,605 ,279 75,929
not satisfied/not dissatisfied	1,072 ,496 2,316	1,552 ,697 3,456	,765 ,190 3,084	2,603 ,374 18,113
satisfied	,740 ,444 1,234	1,101 ,665 1,823	,819 ,319 2,101	1,771 ,367 8,555
Job independency:				
very satisfied	1.0 (-)	1.0 (-)	1.0 (-)	1.0 (-)
very dissatisfied	-	-	-	-
dissatisfied	,252 ,030 2,099	1,090 ,276 4,302	,000 ,000	,000 ,000 .
not satisfied/not dissatisfied	4,099 1,623 10,358	8,093 1,823 35,927	2,920 ,859 9,925	4,418 ,957 20,403
satisfied	1,133 ,738 1,740	1,037 ,688 1,561	,637 ,275 1,477	1,223 ,354 4,223
Communication colleagues:				
very satisfied	1.0 (-)	1.0 (-)	1.0 (-)	1.0 (-)
very dissatisfied	3,539 ,308 40,668	,000	2,922 ,158 53,998	,000 ,000
dissatisfied	1,406 ,477 4,150	2,971 ,784 11,263	1,028 ,161 6,555	1,397 ,115 17,014
not satisfied/not dissatisfied	1,123 ,578 2,185	1,247 ,636 2,447	,732 ,199 2,684	1,638 ,314 8,530
satisfied	,913 ,557 1,497	,799 ,491 1,301	1,058 ,415 2,695	1,537 ,394 6,000
Communication executives:				
very satisfied	1.0 (-)	1.0 (-)	1.0 (-)	1.0 (-)
very dissatisfied	1,397 ,369 5,291	1,413 ,332 6,016	1,918 ,259 14,204	5,874 ,290 118,969
dissatisfied	,313 ,106 ,927	,644 ,260 1,597	,000 ,000	,000 ,000
not satisfied/not dissatisfied	1,173 ,640 2,150	1,449 ,762 2,758	1,086 ,371 3,177	4,787 ,553 41,437
satisfied	,573 ,329 ,996	,634 ,364 1,105	1,170 ,425 3,220	4,660 ,560 38,761
Relation colleagues:				
very satisfied	1.0 (-)	1.0 (-)	1.0 (-)	1.0 (-)
very dissatisfied	,739 ,064 8,484	1,677 ,146 19,284	,000 ,000 .	,000 ,000 .
dissatisfied	,567 ,057 5,665	,280 ,028 2,817	,000 ,000 .	,000 ,000 .
not satisfied/not dissatisfied	,735 ,328	1,112 ,511	,382 ,070	1,186 ,193

		1,650		2,421		2,071		7,300
satisfied	,834	,531	1,151	,737	,408	,181	,711	,239
		1,311		1,799		,920		2,112
Feedback about job done:								
very satisfied	1.0 (-)		1.0 (-)		1.0 (-)		1.0 (-)	
very dissatisfied	,484	,110	1,727	,320	,000		13,843	,771
		2,122		9,336				248,640
dissatisfied	,399	,179	,569	,253	,735	,181	1,142	,136
		,891		1,281		2,984		9,600
not satisfied/not dissatisfied	,725	,356	,971	,447	,603	,183	,946	,152
		1,478		2,107		1,982		5,899
satisfied	,541	,280	,507	,251	,493	,168	1,189	,230
		1,044		1,023		1,450		6,132
Financial reward:								
very satisfied	1.0 (-)		1.0 (-)		1.0 (-)		1.0 (-)	
very dissatisfied	,411	,081	1,787	,337	,598	,050	1,567	,182
		2,098		9,492		7,160		13,500
dissatisfied	,380	,099	1,529	,392	,906	,132	,569	,064
		1,468		5,967		6,200		5,040
not satisfied/not dissatisfied	,446	,119	1,719	,452	,339	,050	,229	,022
		1,672		6,537		2,306		2,393
satisfied	,270	,072	,852	,226	,171	,023	,000	,000
		1,016		3,206		1,282		
Job opportunity:								
very satisfied	1.0 (-)		1.0 (-)		1.0 (-)		1.0 (-)	
very dissatisfied	,269	,062	,453	,102	1,385	,146	3,385	,198
		1,163		2,003		13,133		57,953
dissatisfied	,509	,150	1,332	,353	,318	,061	3,561	,313
		1,722		5,032		1,662		40,542
not satisfied/not dissatisfied	,295	,093	,710	,209	,220	,046	,819	,072
		,935		2,416		1,067		9,327
satisfied	,241	,077	,451	,135	,147	,030	1,113	,108
		,754		1,509		,714		11,508

Table 7b. Binary logistic regression for the association between low back pain (LBP) symptoms (7-day LBP, 12-month LBP, high pain intensity in the lower back (Von Korff pain scale score > 5) during the previous 12 months, disability (Roland & Morris disability scale score ≥ 12) during the last episode of LBP) and job satisfaction and other psychosocial factors in the professional drivers (n=230) over one-year follow-up period. Odds ratios (OR) and 95% confidence intervals (95% CI) are adjusted by age and follow-up time.

Factor	Acute LBP	Sciatica	Treated LBP	Sick leave (>7 days)
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Job satisfaction in general:				
very satisfied	1.0 (-)	1.0 (-)	1.0 (-)	2.0 (-)
very dissatisfied	,000 ,000	,000 ,000	,000 ,000	,000 ,000
dissatisfied	8,545 ,845 86,391	12,636 1,234 129,390	10,384 1,017 106,037	13,862 1,626 118,162
not satisfied/not dissatisfied	1,618 ,735 3,563	1,511 ,628 3,637	,937 ,380 2,309	1,419 ,372 5,411
satisfied	1,489 ,893 2,485	1,136 ,625 2,065	,704 ,393 1,262	1,019 ,396 2,621
Content of work:				
very satisfied	1.0 (-)	1.0 (-)	1.0 (-)	1.0 (-)
very dissatisfied	-	-	-	-
dissatisfied	2,177 ,495 9,575	1,301 ,235 7,214	1,157 ,210 6,374	1,338 ,140 12,764
not satisfied/ not dissatisfied	2,279 1,040 4,994	1,828 ,771 4,335	1,192 ,485 2,929	1,474 ,433 5,013
satisfied	1,202 ,701 2,060	,927 ,499 1,720	,703 ,380 1,303	,642 ,260 1,586
Job independency:				
very satisfied	1.0 (-)	1.0 (-)	1.0 (-)	1.0 (-)
very dissatisfied	-	-	-	-
dissatisfied	2,606 ,651 10,424	,415 ,049 3,511	1,163 ,223 6,056	1,009 ,113 8,995
not satisfied/ not dissatisfied	4,085 1,633 10,215	4,515 1,800 11,329	5,081 2,012 12,833	2,536 ,808 7,963
satisfied	1,394 ,897 2,165	1,052 ,633 1,749	,932 ,545 1,592	,491 ,225 1,071
Communication colleagues:				
very satisfied	1.0 (-)	1.0 (-)	1.0 (-)	1.0 (-)
very dissatisfied	,000 .	7,969 ,682 93,095	,000	4,810 ,391 59,195
dissatisfied	3,018 1,010 9,014	,856 ,219 3,349	2,013 ,646 6,276	1,220 ,235 6,334
not satisfied/not dissatisfied	1,720 ,866 3,413	1,434 ,668 3,077	1,130 ,529 2,415	,872 ,291 2,611
satisfied	1,400 ,830 2,362	1,044 ,576 1,892	,599 ,329 1,092	,544 ,231 1,284
Communication executives:				
very satisfied	1.0 (-)	1.0 (-)	1.0 (-)	1.0 (-)
very dissatisfied	8,276 1,891 36,214	2,258 ,557 9,153	,724 ,139 3,780	,925 ,100 8,527
dissatisfied	1,473 ,540 4,015	,958 ,325 2,824	,508 ,153 1,692	,325 ,038 2,796
not satisfied/not dissatisfied	2,587 1,324 5,054	1,477 ,730 2,991	1,106 ,553 2,212	1,046 ,389 2,814
satisfied	1,480 ,798 2,746	,718 ,368 1,402	,468 ,240 ,910	,507 ,193 1,332
Relation colleagues:				
very satisfied	1.0 (-)	1.0 (-)	1.0 (-)	1.0 (-)
very dissatisfied	1,430 ,124 16,547	1,444 ,124 16,844	9,479 ,804 111,795	,000 ,000 .
dissatisfied	,749 ,074	,000 ,000	,000 ,000	,000 ,000

		7,609		.		.		.
not satisfied/not dissatisfied	1,475	,671	,984	,397	1,875	,775	1,541	,493
		3,243		2,437		4,533		4,813
satisfied	1,153	,721	,861	,508	,931	,523	,499	,222
		1,842		1,459		1,656		1,122
Feedback about job done:								
very satisfied	1.0 (-)		1.0 (-)		1.0 (-)		1.0 (-)	
very dissatisfied	2,090	,516	2,713	,653	2,623	,631	1,809	,294
		8,471		11,269		10,898		11,119
dissatisfied	1,418	,632	,545	,217	,606	,245	,183	,035
		3,182		1,367		1,499		,957
not satisfied/not dissatisfied	1,631	,771	,869	,387	,722	,318	,625	,209
		3,447		1,949		1,637		1,865
satisfied	,894	,442	,539	,253	,373	,172	,346	,123
		1,807		1,148		,811		,976
Financial reward:								
very satisfied	1.0 (-)		1.0 (-)		1.0 (-)		1.0 (-)	
very dissatisfied	2,031	,372	2,608	,244	,869	,153	,419	,047
		11,099		27,914		4,948		3,723
dissatisfied	1,916	,452	2,926	,347	,549	,126	,369	,065
		8,124		24,692		2,384		2,095
not satisfied/not dissatisfied	1,998	,483	2,283	,275	,461	,109	,178	,031
		8,263		18,968		1,949		1,020
satisfied	,830	,199	1,394	,167	,260	,060	,149	,026
		3,452		11,663		1,120		,863
Job opportunity:								
very satisfied	1.0 (-)		1.0 (-)		1.0 (-)		1.0 (-)	
very dissatisfied	,507	,123	,322	,072	,322	,073	,587	,096
		2,086		1,443		1,426		3,583
dissatisfied	1,087	,327	,417	,123	,435	,129	,550	,120
		3,610		1,418		1,460		2,517
not satisfied/not dissatisfied	,473	,153	,288	,091	,208	,066	,247	,057
		1,459		,912		,659		1,067
satisfied	,218	,071	,172	,054	,144	,046	,171	,040
		,673		,542		,452		,737

Table 8. Binary logistic regression of low back pain (LBP) symptoms (7-day LBP, 12-month LBP, and high pain intensity (Von Korff pain scale score > 5), LBP disability (Roland & Morris disability scale score ≥ 12), treated LBP, sick leave due to LBP in the previous 12 months) on groups of professional drivers over one-year follow-up period, assuming the driver group with the lowest WBV exposure (V&W, ZH) as the reference category. Odds ratios (OR) and 95% confidence intervals (95% CI) are adjusted by age and follow-up time. One-year incidence of LBP outcomes (%) within each driver group is also given.

Outcome	Driver groups in the different companies					
	10 (n=11)	1 (n=11)	2 (n=10)	3 (n=25)	4 (n=13)	5 (n=2)
7-day LBP (%) OR (95% CI)	10.0 1.0 (-)	33.3 ,164 ,028 ,954	14.3 ,063 ,007 ,579	15.8 ,427 ,138 1,320	0.0 ,489 ,091 2,636	0.0 -
12-month LBP (%) OR (95% CI)	0.0 1.0 (-)	66.7 ,287 ,064 1,301	28.6 ,235 ,054 1,033	15.8 1,047 ,335 3,269	0.0 1,214 ,224 6,590	0.0 -
Acute LBP (%) OR (95% CI)	0.0 1.0 (-)	16.7 ,080 ,009 ,746	14.3 ,068 ,007 ,634	5.3 ,545 ,178 1,666	0.0 ,358 ,057 2,231	0.0 2,326 ,201 26,960
Sciatica (%) OR (95% CI)	0.0 1.0 (-)	0.0 ,000 ,000 .	28.6 ,227 ,040 1,303	5.3 ,493 ,151 1,606	0.0 ,000 ,000 .	0.0 ,949 ,071 12,672
High pain intensity (%) OR (95% CI)	10.0 1.0 (-)	0.0 ,000 ,000 .	14.3 ,200 ,021 1,907	5.3 ,081 ,009 ,753	0.0 ,000 ,000 .	0.0 1,205 ,096 15,080
LBP disability (%) OR (95% CI)	10.0 1.0 (-)	0.0 ,000 ,000 .	0.0 ,000 ,000 .	0.0 ,000 ,000 .	0.0 ,481 ,044 5,231	0.0 2,530 ,170 37,736
Treated LBP (%) OR (95% CI)	0.0 1.0 (-)	0.0 ,000 ,000 .	14.3 ,124 ,013 1,148	10.5 ,399 ,115 1,380	0.0 ,835 ,153 4,546	0.0 ,649 ,055 7,664
Sick leave (> 7d) (%) OR (95% CI)	0.0 1.0 (-)	16.7 ,553 ,050 6,150	0.0 ,000 ,000 .	0.0 ,770 ,148 4,018	0.0 1,595 ,209 12,203	0.0 ,000 ,000 .
Outcome	Driver groups					

	7 (n=13)	8 (n=5)	9 (n=57)	11 (n=6)	12 (n=13)	13 (n=128)
7-day LBP (%) OR (95% CI)	20.0 ,273 ,071 1,055	0.0 1,376 ,250 7,561	23.3 ,396 ,145 1,084	0.0 ,164 ,016 1,673	18.2 ,568 ,166 1,944	17.1 ,444 ,175 1,129
12-month LBP (%) OR (95% CI)	30.0 ,575 ,162 2,040	0.0 -	16.3 ,947 ,344 2,606	0.0 -	9.1 ,593 ,172 2,035	9.0 ,832 ,324 2,136
Acute LBP (%) OR (95% CI)	20.0 ,473 ,131 1,710	0.0 2,430 ,382 15,443	14.0 ,562 ,207 1,523	0.0 ,451 ,066 3,103	18.2 ,626 ,183 2,145	7.2 ,386 ,151 ,983
Sciatica (%) OR (95% CI)	30.0 ,256 ,056 1,172	0.0 1,765 ,325 9,580	9.3 ,375 ,131 1,067	0.0 ,690 ,099 4,799	0.0 ,140 ,025 ,770	11.8 ,406 ,157 1,047
High pain intensity (%) OR (95% CI)	0.0 ,000 ,000 .	0.0 1,109 ,161 7,660	4.7 ,257 ,073 ,905	33.3 ,517 ,048 5,545	9.1 ,127 ,014 1,185	5.4 ,284 ,097 ,831
LBP disability (%) OR (95% CI)	0.0 ,000 ,000 .	0.0 ,000 ,000 .	0.0 ,126 ,020 ,778	0.0 ,000 ,000 .	0.0 ,000 ,000 .	3.6 ,303 ,086 1,074
Treated LBP (%) OR (95% CI)	0.0 ,000 ,000 .	0.0 1,125 ,200 6,337	9.3 ,364 ,124 1,066	33.3 1,649 ,258 10,521	0.0 ,364 ,088 1,499	9.0 ,374 ,142 ,987
Sick leave (> 7d) (%) OR (95% CI)	0.0 ,000 ,000 .	25.0 2,364 ,292 19,152	4.7 ,648 ,150 2,803	0.0 ,000 ,000 .	9.1 ,591 ,087 4,039	3.6 ,341 ,086 1,356

Table 9a. Binary logistic regression of low back pain in the previous 7 days on alternative measures of daily exposure to whole-body vibration (WBV) in the professional drivers (n=230) over one-year follow-up period. Odds ratio (OR) and 95% confidence interval (95% CI) are adjusted for several covariates (Age, physical load factors, psychosocial factors, back trauma, and follow-up time). Each measure of WBV exposure was included as a quartile based design variable, assuming the lowest quartile as the reference category. The likelihood ratio (LR) test for the measures of WBV exposure is given.

Measures of daily WBV exposure		Quartiles of measure of daily WBV exposure							LR test (χ^2, 3*df*)
		Q1	Q2		Q3		Q4		
Daily driving time (h)	median	5.0	8.0		9.4		11.0		6.0506
OR		1.0	1.509		2.075		1.475		0.1092
	(95% CI)	(-)	0.818	2.786	1.158	3.720	0.696	3.126	
$A_v(8)$ (ms^{-2} r.m.s.)	median	0.28	0.45		0.56		0.74		1.1169
	OR	1.0	0.836		0.722		0.820		0.7730
	(95% CI)	(-)	0.458	1.524	0.392	1.331	0.452	1.489	
$A_{dom}(8)$ (ms^{-2} r.m.s.)	median	0.18	0.32		0.39		0.53		3.6110
	OR	1.0	1.045		0.586		0.810		0.3066
	(95% CI)	(-)	0.594	1.837	0.299	1.147	0.435	1.510	
VDV_v ($ms^{-1.75}$)	median	3.20	4.90		6.46		11.83		4.6941
	OR	1.0	0.777		0.512		0.895		0.1956
	(95% CI)	(-)	0.429	1.406	0.271	0.968	0.497	1.614	
VDV_{dom} ($ms^{-1.75}$)	median	3.26	4.56		5.81		10.34		3.6863
	OR	1.0	0.997		0.583		0.994		0.2974
	(95% CI)	(-)	0.542	1.835	0.313	1.086	0.565	1.749	

Table 9b. Binary logistic regression of low back pain in the previous 7 days on alternative measures of cumulative exposure in most recent job, to whole-body vibration (WBV) in the professional drivers (n=230) over one-year follow-up period. Odds ratio (OR) and 95% confidence interval (95% CI) are adjusted for several covariates (Age, physical load factors, psychosocial factors, back trauma and follow-up time). Each measure of WBV exposure was included as a quartile based design variable, assuming the lowest quartile as the reference category. The likelihood ratio (LR) test for the measures of WBV exposure is given. The likelihood ratio (LR) test for the measures of WBV exposure and the Bayesan Information Criteria (BIC) for comparison between models are given.

Measures of cumulative WBV exposure		Quartiles of measure of cumulative WBV exposure				LR test (χ^2, 3*df*)
		Q1	Q2	Q3	Q4	
Exposure duration (yr)	median	3.2	10.1	21.6	34.8	4.1716
	OR	1.0	0.726	1.404	1.109	0.2435
	(95% CI)	(-)	0.385 1.369	0.748 2.637	0.524 2.348	
$\sum[t_i]$ (h $\times 10^3$)	median	4.6	16.7	34.9	60.7	3.6200
	OR	1.0	1.054	1.513	1.830	0.3055
	(95% CI)	(-)	0.561 1.980	0.778 2.940	0.884 3.791	
$\sum[a_{wsi}t_i]$(ms^{-2}h$\times 10^3$)	median	2.8	7.7	16.4	38.2	2.9789
	OR	1.0	1.071	0.980	1.620	0.3949
	(95% CI)	(-)	0.574 1.998	0.512 1.877	0.808 3.250	
$\sum[a_{wsi}^2 t_i]$ (m^{2}s^{-4}h $\times 10^3$)	median	1.1	4.0	8.9	26.9	3.9204
	OR	1.0	0.775	0.609	1.061	0.2702
	(95% CI)	(-)	0.424 1.417	0.324 1.146	0.560 2.009	
$\sum[a_{wsi}^4 t_i]$ (m^{4}s^{-8}h $\times 10^3$)	median	0.29	1.2	3.3	14.1	3.4130
	OR	1.0	0.575	0.842	0.923	0.3322
	(95% CI)	(-)	0.310 1.067	0.465 1.523	0.499 1.704	
$\sum[a_{wqi}t_i]$ (ms^{-2}h $\times 10^3$)	median	1.95	5.60	12.16	27.73	6.9040
	OR	1.0	0.782	0.720	1.545	0.0750
	(95% CI)	(-)	0.423 1.444	0.376 1.380	0.795 3.002	
$\sum[a_{wqi}^2 t_i]$ (m^{2}s^{-4}h $\times 10^3$)	median	0.59	2.36	4.94	14.49	3.8046
	OR	1.0	0.774	0.634	1.102	0.2833
	(95% CI)	(-)	0.424 1.413	0.339 1.187	0.584 2.078	
$\sum[a_{wqi}^4 t_i]$ (m^{4}s^{-8}h $\times 10^3$)	median	0.1	0.36	0.99	4.09	4.6734
	OR	1.0	0.516	0.832	0.881	0.1973
	(95% CI)	(-)	0.276 0.964	0.461 1.501	0.477 1.629	

Table 10a. Binary logistic regression of low back pain in the previous 12 months on alternative measures of daily exposure to whole-body vibration (WBV) in the professional drivers (n=230) over one-year follow-up period. Odds ratio (OR) and 95% confidence interval (95% CI) are adjusted for several covariates (Age, physical load factors, psychosocial factors, back trauma, and follow-up time). Each measure of WBV exposure was included as a quartile based design variable, assuming the lowest quartile as the reference category. The likelihood ratio (LR) test for the measures of WBV exposure is given. The likelihood ratio (LR) test for the measures of WBV exposure and the Bayesan Information Criteria (BIC) for comparison between models are given.

Measures of daily WBV exposure		Quartiles of measure of daily WBV exposure							LR test (χ^2, 3*df*)
		Q1	Q2		Q3		Q4		
Daily driving time (h)	median	5.0	8.0		9.4		11.0		4.2805
	OR	1.0	0.902		1.327		1.587		0.2327
	(95% CI)	(-)	0.537	1.517	0.798	2.204	0.813	3.098	
$A_v(8)$ (ms^{-2} r.m.s.)	median	0.28	0.45		0.56		0.74		1.7595
	OR	1.0	0.823		0.777		0.699		0.6238
	(95% CI)	(-)	0.474	1.428	0.446	1.351	0.408	1.198	
$A_{dom}(8)$ (ms^{-2} r.m.s.)	median	0.18	0.32		0.39		0.53		1.3109
	OR	1.0	0.889		0.741		0.777		0.7265
	(95% CI)	(-)	0.525	1.506	0.417	1.318	0.444	1.360	
VDV_v ($ms^{-1.75}$)	median	3.20	4.90		6.46		11.83		7.0628
	OR	1.0	0.499		0.689		0.877		0.0699
	(95% CI)	(-)	0.287	0.867	0.394	1.205	0.505	1.520	
VDV_{dom} ($ms^{-1.75}$)	median	3.26	4.56		5.81		10.34		1.6198
	OR	1.0	0.907		0.867		1.211		0.6549
	(95% CI)	(-)	0.518	1.589	0.511	1.470	0.723	2.031	

Table 10b. Binary logistic regression of low back pain in the previous 12 months on alternative measures of cumulative exposure in most recent job, to whole-body vibration (WBV) in the professional drivers (n=230) over one-year follow-up period. Odds ratio (OR) and 95% confidence interval (95% CI) are adjusted for several covariates (Age, marital status, physical load factors, psychosocial factors, back trauma and follow-up time). Each measure of WBV exposure was included as a quartile based design variable, assuming the lowest quartile as the reference category. The likelihood ratio (LR) test for the measures of WBV exposure is given.

Measures of cumulative WBV exposure		Quartiles of measure of cumulative WBV exposure							LR test (χ^2, 3*df*)
		Q1	Q2		Q3		Q4		
Exposure duration (yr)	median	3.2	10.1		21.6		34.8		0.9136
	OR	1.0	0.907		1.186		1.073		0.8222
	(95% CI)	(-)	0.521	1.578	0.661	2.130	0.553	2.082	
$\sum[t_i]$ (h $\times 10^3$)	median	4.6	16.7		34.9		60.7		6.5962
	OR	1.0	1.255		2.141		1.482		0.0859
	(95% CI)	(-)	0.718	2.192	1.177	3.895	0.778	2.823	
$\sum[a_{wsi}t_i]$($ms^{-2}h \times 10^3$)	median	2.8	7.7		16.4		38.2		0.5396
	OR	1.0	1.201		1.007		1.040		0.9101
	(95% CI)	(-)	0.679	2.122	0.570	1.778	0.557	1.941	
$\sum[a_{wsi}{}^2t_i]$ ($m^2s^{-4}h \times 10^3$)	median	1.1	4.0		8.9		26.9		1.4817
	OR	1.0	0.939		1.079		0.774		0.6865
	(95% CI)	(-)	0.538	1.640	0.613	1.899	0.428	1.402	
$\sum[a_{wsi}{}^4t_i]$ ($m^4s^{-8}h \times 10^3$)	median	0.29	1.2		3.3		14.1		2.0737
	OR	1.0	0.772		1.120		0.863		0.5573
	(95% CI)	(-)	0.447	1.331	0.644	1.948	0.492	1.512	
$\sum[a_{wqi}t_i]$ ($ms^{-2}h \times 10^3$)	median	1.95	5.60		12.16		27.73		0.6562
	OR	1.0	1.200		0.989		1.123		0.8835
	(95% CI)	(-)	0.684	2.104	0.562	1.738	0.609	2.071	
$\sum[a_{wqi}{}^2t_i]$ ($m^2s^{-4}h \times 10^3$)	median	0.59	2.36		4.94		14.49		1.7831
	OR	1.0	0.906		1.213		0.856		0.6186
	(95% CI)	(-)	0.521	1.575	0.690	2.131	0.475	1.545	
$\sum[a_{wqi}{}^4t_i]$ ($m^4s^{-8}h \times 10^3$)	median	0.1	0.36		0.99		4.09		4.9555
	OR	1.0	0.697		1.246		0.807		0.1751
	(95% CI)	(-)	0.403	1.205	0.709	2.192	0.457	1.424	

Table 11a. Binary logistic regression of acute low back pain in the previous 12 months on alternative measures of daily exposure to whole-body vibration (WBV) in the professional drivers (n=230) over one-year follow-up period. Odds ratio (OR) and 95% confidence interval (95% CI) are adjusted for several covariates (Age, previous jobs at risk, physical load factors, psychosocial factors, back trauma, and follow-up time). Each measure of WBV exposure was included as a quartile based design variable, assuming the lowest quartile as the reference category. The likelihood ratio (LR) test for the measures of WBV exposure is given.

Measures of daily WBV exposure		Quartiles of measure of daily WBV exposure				LR test (χ^2, 3*df*)
		Q1	Q2	Q3	Q4	
Daily driving time (h)	median OR (95% CI)	5.0 1.0 (-)	8.0 1.513 0.831 2.756	9.4 2.124 1.212 3.722	11.0 1.992 0.993 3.995	7.7566 0.0513
$A_v(8)$ (ms^{-2} r.m.s.)	median OR (95% CI)	0.28 1.0 (-)	0.45 1.468 0.815 2.645	0.56 1.004 0.546 1.848	0.74 1.156 0.636 2.099	2.1917 0.5336
$A_{dom}(8)$ (ms^{-2} r.m.s.)	median OR (95% CI)	0.18 1.0 (-)	0.32 1.096 0.625 1.921	0.39 0.723 0.378 1.382	0.53 1.068 0.582 1.958	2.0596 0.5601
VDV_v ($ms^{-1.75}$)	median OR (95% CI)	3.20 1.0 (-)	4.90 0.828 0.452 1.517	6.46 0.935 0.513 1.706	11.83 1.039 0.575 1.877	0.6176 0.8924
VDV_{dom} ($ms^{-1.75}$)	median OR (95% CI)	3.26 1.0 (-)	4.56 0.811 0.433 1.520	5.81 0.939 0.524 1.683	10.34 1.172 0.668 2.057	1.3102 0.7267

Table 11b. Binary logistic regression of acute low back pain in the previous 12 months on alternative measures of cumulative exposure in most recent job, to whole-body vibration (WBV) in the professional drivers (n=230) over one-year follow-up period. Odds ratio (OR) and 95% confidence interval (95% CI) are adjusted for several covariates (Age, physical load factors, psychosocial factors, back trauma and follow-up time). Each measure of WBV exposure was included as a quartile based design variable, assuming the lowest quartile as the reference category. The likelihood ratio (LR) test for the measures of WBV exposure is given.

Measures of cumulative WBV exposure		Quartiles of measure of cumulative WBV exposure				LR test (χ^2, 3*df*)
		Q1	Q2	Q3	Q4	
Exposure duration (yr)	median	3.2	10.1	21.6	34.8	2.6798
	OR	1.0	1.221	1.617	1.656	0.4437
	(95% CI)	(-)	0.674 2.213	0.867 3.016	0.788 3.480	
$\Sigma[t_i]$ ($h \times 10^3$)	median	4.6	16.7	34.9	60.7	9.7908
	OR	1.0	1.900	1.887	3.237	0.0204
	(95% CI)	(-)	1.025 3.522	0.964 3.693	1.541 6.800	
$\Sigma[a_{wsi}t_i]$($ms^{-2}h \times 10^3$)	median	2.8	7.7	16.4	38.2	6.2678
	OR	1.0	1.727	1.419	2.335	0.0993
	(95% CI)	(-)	0.939 3.177	0.751 2.681	1.160 4.699	
$\Sigma[a_{wsi}^2t_i]$ ($m^2s^{-4}h \times 10^3$)	median	1.1	4.0	8.9	26.9	4.6907
	OR	1.0	1.677	1.479	1.989	0.1959
	(95% CI)	(-)	0.917 3.066	0.798 2.740	1.033 3.832	
$\Sigma[a_{wsi}^4t_i]$ ($m^4s^{-8}h \times 10^3$)	median	0.29	1.2	3.3	14.1	1.1811
	OR	1.0	1.188	1.332	1.340	0.7575
	(95% CI)	(-)	0.657 2.146	0.739 2.400	0.726 2.473	
$\Sigma[a_{wqi}t_i]$ ($ms^{-2}h \times 10^3$)	median	1.95	5.60	12.16	27.73	11.4287
	OR	1.0	2.030	1.431	2.963	0.0096
	(95% CI)	(-)	1.107 3.724	0.748 2.739	1.486 5.907	
$\Sigma[a_{wqi}^2t_i]$ ($m^2s^{-4}h \times 10^3$)	median	0.59	2.36	4.94	14.49	7.3004
	OR	1.0	1.933	1.500	2.304	0.0629
	(95% CI)	(-)	1.057 3.535	0.808 2.786	1.195 4.440	
$\Sigma[a_{wqi}^4t_i]$ ($m^4s^{-8}h \times 10^3$)	median	0.1	0.36	0.99	4.09	2.9633
	OR	1.0	0.903	1.447	1.257	0.3973
	(95% CI)	(-)	0.497 1.642	0.809 2.586	0.683 2.314	

Table 12a. Binary logistic regression of sciatica in the previous 12 months on alternative measures of daily exposure to whole-body vibration (WBV) in the professional drivers (n=230) over one-year follow-up period. Odds ratio (OR) and 95% confidence interval (95% CI) are adjusted for several covariates (Age, BMI, marital status, physical load factors, psychosocial factors, back trauma, and follow-up time). Each measure of WBV exposure was included as a quartile based design variable, assuming the lowest quartile as the reference category. The likelihood ratio (LR) test for the measures of WBV exposure is given.

Measures of daily WBV exposure		Quartiles of measure of daily WBV exposure				LR test (χ^2, 3*df*)
		Q1	Q2	Q3	Q4	
Daily driving time (h)	median OR (95% CI)	5.0 1.0 (-)	8.0 0.912 0.440 1.890	9.4 1.958 1.034 3.708	11.0 1.430 0.645 3.166	6.9356 0.0740
$A_v(8)$ (ms^{-2} r.m.s.)	median OR (95% CI)	0.28 1.0 (-)	0.45 1.109 0.569 2.162	0.56 1.065 0.537 2.113	0.74 0.696 0.343 1.414	1.9715 0.5783
$A_{dom}(8)$ (ms^{-2} r.m.s.)	median OR (95% CI)	0.18 1.0 (-)	0.32 1.367 0.712 2.624	0.39 1.072 0.511 2.249	0.53 0.924 0.442 1.934	1.5579 0.6690
VDV_v ($ms^{-1.75}$)	median OR (95% CI)	3.20 1.0 (-)	4.90 0.933 0.465 1.873	6.46 0.726 0.354 1.486	11.83 1.262 0.645 2.470	2.3962 0.4943
VDV_{dom} ($ms^{-1.75}$)	median OR (95% CI)	3.26 1.0 (-)	4.56 0.848 0.407 1.767	5.81 0.662 0.328 1.338	10.34 1.270 0.673 2.394	3.3537 0.3402

Table 12b. Binary logistic regression of sciatica in the previous 12 months on alternative measures of cumulative exposure in most recent job, to whole-body vibration (WBV) in the professional drivers (n=230) over one-year follow-up period. Odds ratio (OR) and 95% confidence interval (95% CI) are adjusted for several covariates (Age, BMI, physical load factors, psychosocial factors, back trauma and follow-up time). Each measure of WBV exposure was included as a quartile based design variable, assuming the lowest quartile as the reference category. The likelihood ratio (LR) test for the measures of WBV exposure is given.

Measures of cumulative WBV exposure		Quartiles of measure of cumulative WBV exposure				LR test (χ^2, 3*df*)
		Q1	Q2	Q3	Q4	
Exposure duration (yr)	median	3.2	10.1	21.6	34.8	5.5333
	OR	1.0	0.475	0.819	1.150	0.1367
	(95% CI)	(-)	0.219 1.030	0.400 1.675	0.511 2.589	
$\sum[t_i]$ (h $\times 10^3$)	median	4.6	16.7	34.9	60.7	6.2702
	OR	1.0	0.854	1.765	1.976	0.0992
	(95% CI)	(-)	0.385 1.892	0.821 3.794	0.859 4.546	
$\sum[a_{wsi}t_i]$(ms^{-2}h$\times 10^3$)	median	2.8	7.7	16.4	38.2	3.1438
	OR	1.0	1.835	1.429	1.860	0.3700
	(95% CI)	(-)	0.874 3.851	0.660 3.095	0.828 4.181	
$\sum[a_{wsi}^2t_i]$ (m^{2}s^{-4}h $\times 10^3$)	median	1.1	4.0	8.9	26.9	2.1875
	OR	1.0	1.537	0.984	1.094	0.5344
	(95% CI)	(-)	0.770 3.068	0.477 2.028	0.522 2.291	
$\sum[a_{wsi}^4t_i]$ (m^{4}s^{-8}h $\times 10^3$)	median	0.29	1.2	3.3	14.1	0.4079
	OR	1.0	0.870	0.877	0.804	0.9386
	(95% CI)	(-)	0.437 1.731	0.448 1.716	0.404 1.601	
$\sum[a_{wqi}t_i]$ (ms^{-2}h $\times 10^3$)	median	1.95	5.60	12.16	27.73	2.1759
	OR	1.0	1.592	1.238	1.617	0.5367
	(95% CI)	(-)	0.774 3.275	0.580 2.641	0.744 3.513	
$\sum[a_{wqi}^2t_i]$ (m^{2}s^{-4}h $\times 10^3$)	median	0.59	2.36	4.94	14.49	2.9711
	OR	1.0	1.654	1.001	1.370	0.3961
	(95% CI)	(-)	0.826 3.313	0.480 2.089	0.654 2.872	
$\sum[a_{wqi}^4t_i]$ (m^{4}s^{-8}h $\times 10^3$)	median	0.1	0.36	0.99	4.09	1.0726
	OR	1.0	0.891	1.229	0.912	0.7837
	(95% CI)	(-)	0.440 1.804	0.628 2.405	0.450 1.845	

Table 13a. Binary logistic regression of high pain intensity in the lower back (von korff pain scale > 5) on alternative measures of daily exposure to whole-body vibration (WBV) in the professional drivers (n=230) over one-year follow-up period. Odds ratio (OR) and 95% confidence interval (95% CI) are adjusted for several covariates (Age, smoking, physical load factors, psychosocial factors, back trauma, and follow-up time). Each measure of WBV exposure was included as a quartile based design variable, assuming the lowest quartile as the reference category. The likelihood ratio (LR) test for the measures of WBV exposure is given.

Measures of daily WBV exposure		Quartiles of measure of daily WBV exposure				LR test (χ^2, 3*df*)
		Q1	Q2	Q3	Q4	
Daily driving time (h)	median OR (95% CI)	5.0 1.0 (-)	8.0 1.965 0.590 6.543	9.4 5.623 1.984 15.931	11.0 0.783 0.194 3.162	14.3401 0.0025
$A_v(8)$ (ms^{-2} r.m.s.)	median OR (95% CI)	0.28 1.0 (-)	0.45 0.517 0.186 1.439	0.56 0.634 0.238 1.687	0.74 0.518 0.184 1.455	2.3889 0.4957
$A_{dom}(8)$ (ms^{-2} r.m.s.)	median OR (95% CI)	0.18 1.0 (-)	0.32 1.391 0.549 3.526	0.39 0.471 0.137 1.613	0.53 0.821 0.274 2.457	3.2813 0.3503
VDV_v ($ms^{-1.75}$)	median OR (95% CI)	3.20 1.0 (-)	4.90 0.954 0.358 2.541	6.46 0.730 0.253 2.107	11.83 0.518 0.180 1.497	1.7329 0.6296
VDV_{dom} ($ms^{-1.75}$)	median OR (95% CI)	3.26 1.0 (-)	4.56 0.866 0.304 2.470	5.81 0.789 0.277 2.246	10.34 0.618 0.227 1.687	0.9022 0.8249

Table 13b. Binary logistic regression of high pain intensity in the lower back (von Korff pain scale > 5) on alternative measures of cumulative exposure in most recent job, to whole-body vibration (WBV) in the professional drivers (n=230) over one-year follow-up period. Odds ratio (OR) and 95% confidence interval (95% CI) are adjusted for several covariates (Age, smoking, physical load factors, psychosocial factors, back trauma and follow-up time). Each measure of WBV exposure was included as a quartile based design variable, assuming the lowest quartile as the reference category. The likelihood ratio (LR) test for the measures of WBV exposure is given.

Measures of cumulative WBV exposure		Quartiles of measure of cumulative WBV exposure				LR test (χ^2, 3*df*)
		Q1	Q2	Q3	Q4	
Exposure duration (yr)	median	3.2	10.1	21.6	34.8	9.1507
	OR	1.0	0.189	0.505	1.234	0.0274
	(95% CI)	(-)	0.048 0.746	0.163 1.564	0.361 4.215	
$\sum[t_i]$ (h $\times 10^3$)	median	4.6	16.7	34.9	60.7	5.0035
	OR	1.0	0.372	1.088	1.477	0.1715
	(95% CI)	(-)	0.090 1.539	0.326 3.623	0.406 5.366	
$\sum[a_{wsi}t_i]$($ms^{-2}h\times10^3$)	median	2.8	7.7	16.4	38.2	1.5192
	OR	1.0	0.797	0.475 0.139	0.736	0.6778
	(95% CI)	(-)	0.267 2.373	1.621	0.234 2.322	
$\sum[a_{wsi}^2 t_i]$ ($m^2s^{-4}h \times10^3$)	median	1.1	4.0	8.9	26.9	4.6334
	OR	1.0	0.511	0.322	0.424	0.2007
	(95% CI)	(-)	0.176 1.481	0.107 0.976	0.149 1.202	
$\sum[a_{wsi}^4 t_i]$ ($m^4s^{-8}h \times10^3$)	median	0.29	1.2	3.3	14.1	7.0351
	OR	1.0	0.248	0.419	0.386	0.0708
	(95% CI)	(-)	0.073 0.842	0.156 1.121	0.144 1.034	
$\sum[a_{wqi}t_i]$ ($ms^{-2}h \times10^3$)	median	1.95	5.60	12.16	27.73	1.2964
	OR	1.0	0.731	0.511	0.745	0.7300
	(95% CI)	(-)	0.246 2.173	0.159 1.640	0.247 2.249	
$\sum[a_{wqi}^2 t_i]$ ($m^2s^{-4}h \times10^3$)	median	0.59	2.36	4.94	14.49	2.2839
	OR	1.0	0.681	0.459	0.537	0.5156
	(95% CI)	(-)	0.241 1.924	0.155 1.356	0.187 1.544	
$\sum[a_{wqi}^4 t_i]$ ($m^4s^{-8}h \times10^3$)	median	0.1	0.36	0.99	4.09	5.1809
	OR	1.0	0.329	0.464	0.406	0.1590
	(95% CI)	(-)	0.103 1.052	0.172 1.255	0.149 1.106	

Table 14a. Binary logistic regression of disability (Roland & Morris disability scale score≥ 12) during the last episode of LBP on alternative measures of daily exposure to whole-body vibration (WBV) in the professional drivers (n=230) over one-year follow-up period. Odds ratio (OR) and 95% confidence interval (95% CI) are adjusted for several covariates (Age, physical load factors, psychosocial factors, back trauma, and follow-up time). Each measure of WBV exposure was included as a quartile based design variable, assuming the lowest quartile as the reference category. The likelihood ratio (LR) test for the measures of WBV exposure is given.

Measures of daily WBV exposure		Quartiles of measure of daily WBV exposure				LR test (χ^2, 3*df*)
		Q1	Q2	Q3	Q4	
Daily driving time (h)	median	5.0	8.0	9.4	11.0	6.4716
	OR	1.0	6.870	9.611	5.149	0.0908
	(95% CI)	(-)	1.044 45.212	1.671 55.298	0.769 34.465	
$A_v(8)$ (ms^{-2} r.m.s.)	median	0.28	0.45	0.56	0.74	7.2833
	OR	1.0	0.250	0.199	0.268	0.0634
	(95% CI)	(-)	0.057 1.104	0.045 0.884	0.069 1.040	
$A_{dom}(8)$ (ms^{-2} r.m.s.)	median	0.18	0.32	0.39	0.53	3.6843
	OR	1.0	0.426	0.287	0.364	0.2976
	(95% CI)	(-)	0.116 1.568	0.062 1.342	0.091 1.455	
VDV_v ($ms^{-1.75}$)	median	3.20	4.90	6.46	11.83	3.6325
	OR	1.0	0.275	0.618 0.163	0.341	0.3040
	(95% CI)	(-)	0.055 1.365	2.347	0.087 1.337	
VDV_{dom} ($ms^{-1.75}$)	median	3.26	4.56	5.81	10.34	6.4560
	OR	1.0	0.105	0.531	0.258	0.0914
	(95% CI)	(-)	0.015 0.739	0.139 2.025	0.063 1.056	

Table 14b. Binary logistic regression of disability (Roland & Morris disability scale score≥ 12) during the last episode of LBP on alternative measures of cumulative exposure in most recent job, to whole-body vibration (WBV) in the professional drivers (n=230) over one-year follow-up period. Odds ratio (OR) and 95% confidence interval (95% CI) are adjusted for several covariates (Age, previous jobs at risks, physical load factors, psychosocial factors, back trauma and follow-up time). Each measure of WBV exposure was included as a quartile based design variable, assuming the lowest quartile as the reference category. The likelihood ratio (LR) test for the measures of WBV exposure is given.

Measures of cumulative WBV exposure		Quartiles of measure of cumulative WBV exposure				LR test (χ^2, 3*df*)
		Q1	Q2	Q3	Q4	
Exposure duration (yr)	median	3.2	10.1	21.6	34.8	1.7167
	OR	1.0	4.287	3.871	5.534	0.6332
	(95% CI)	(-)	0.395 46.574	0.352 42.607	0.394 77.813	
$\sum[t_i]$ (h $\times 10^3$)	median	4.6	16.7	34.9	60.7	0.3621
	OR	1.0	-	-	-	0.9480
	(95% CI)	(-)				
$\sum[a_{wsi}t_i]$(ms^{-2}h$\times 10^3$)	median	2.8	7.7	16.4	38.2	9.5178
	OR	1.0	5.000	0.407	1.204	0.0231
	(95% CI)	(-)	0.774 32.287	0.038 4.375	0.163 8.914	
$\sum[a_{wsi}^2 t_i]$ (m^{2}s^{-4}h $\times 10^3$)	median	1.1	4.0	8.9	26.9	2.9605
	OR	1.0	0.490	0.270	0.386	0.3978
	(95% CI)	(-)	0.098 2.442	0.054 1.342	0.092 1.614	
$\sum[a_{wsi}^4 t_i]$ (m^{4}s^{-8}h $\times 10^3$)	median	0.29	1.2	3.3	14.1	8.9373
	OR	1.0	0.056	0.219	0.245	0.0301
	(95% CI)	(-)	0.006 0.520	0.049 0.983	0.064 0.942	
$\sum[a_{wqi}t_i]$ (ms^{-2}h $\times 10^3$)	median	1.95	5.60	12.16	27.73	9.5720
	OR	1.0	8.999	1.167	2.174	0.0226
	(95% CI)	(-)	0.945 85.652	0.090 15.075	0.205 23.077	
$\sum[a_{wqi}^2 t_i]$ (m^{2}s^{-4}h $\times 10^3$)	median	0.59	2.36	4.94	14.49	1.7554
	OR	1.0	0.473	0.404	0.436	0.6247
	(95% CI)	(-)	0.096 2.325	0.088 1.857	0.101 1.881	
$\sum[a_{wqi}^4 t_i]$ (m^{4}s^{-8}h $\times 10^3$)	median	0.1	0.36	0.99	4.09	6.9508
	OR	1.0	0.107	0.252	0.266	0.0735
	(95% CI)	(-)	0.015 0.754	0.056 1.137	0.068 1.047	

Table 15a. Binary logistic regression of treated LBP in the previous 12 months on alternative measures of daily exposure to whole-body vibration (WBV) in the professional drivers (n=230) over one-year follow-up period. Odds ratio (OR) and 95% confidence interval (95% CI) are adjusted for several covariates (Age, physical load factors, psychosocial factors, back trauma, and follow-up time). Each measure of WBV exposure was included as a quartile based design variable, assuming the lowest quartile as the reference category. The likelihood ratio (LR) test for the measures of WBV exposure is given.

Measures of daily WBV exposure		Quartiles of measure of daily WBV exposure							LR test (χ^2, 3*df*)
		Q1	Q2		Q3		Q4		
Daily driving time (h)	median	5.0	8.0		9.4		11.0		8.2294
	OR	1.0	1.280		2.226		2.415		0.0415
	(95% CI)	(-)	0.612	2.679	1.147	4.320	1.098	5.310	
$A_v(8)$ (ms^{-2} r.m.s.)	median	0.28	0.45		0.56		0.74		0.5268
	OR	1.0	0.785		0.833		0.859		0.9130
	(95% CI)	(-)	0.391	1.576	0.422	1.645	0.439	1.678	
$A_{dom}(8)$ (ms^{-2} r.m.s.)	median	0.18	0.32		0.39		0.53		2.0979
	OR	1.0	0.963		0.596		0.934		0.5523
	(95% CI)	(-)	0.505	1.835	0.276	1.283	0.470	1.856	
VDV_v ($ms^{-1.75}$)	median	3.20	4.90		6.46		11.83		2.4565
	OR	1.0	0.638		0.866		1.109		0.4832
	(95% CI)	(-)	0.309	1.317	0.431	1.740	0.573	2.146	
VDV_{dom} ($ms^{-1.75}$)	median	3.26	4.56		5.81		10.34		2.4742
	OR	1.0	0.841		0.882		1.393		0.4800
	(95% CI)	(-)	0.399	1.772	0.436	1.783	0.736	2.636	

Table 15b. Binary logistic regression of treated LBP in the previous 12 months on alternative measures of cumulative exposure in most recent job, to whole-body vibration (WBV) in the professional drivers (n=230) over one-year follow-up period. Odds ratio (OR) and 95% confidence interval (95% CI) are adjusted for several covariates (Age, physical load factors, psychosocial factors, back trauma and follow-up time). Each measure of WBV exposure was included as a quartile based design variable, assuming the lowest quartile as the reference category. The likelihood ratio (LR) test for the measures of WBV exposure is given.

Measures of cumulative WBV exposure		Quartiles of measure of cumulative WBV exposure				LR test (χ^2, 3*df*)
		Q1	Q2	Q3	Q4	
Exposure duration (yr)	median OR (95% CI)	3.2 1.0 (-)	10.1 0.588 0.279 1.238	21.6 0.805 0.392 1.657	34.8 0.926 0.407 2.103	2.3346 0.5059
$\Sigma[t_i]$ (h $\times 10^3$)	median OR (95% CI)	4.6 1.0 (-)	16.7 0.950 0.437 2.068	34.9 1.616 0.749 3.486	60.7 1.473 0.636 3.409	2.8001 0.4235
$\Sigma[a_{wsi}t_i]$($ms^{-2}h\times 10^3$)	median OR (95% CI)	2.8 1.0 (-)	7.7 1.189 0.566 2.499	16.4 1.227 0.571 2.637	38.2 1.329 0.598 2.951	0.4992 0.9191
$\Sigma[a_{wsi}{}^2t_i]$ ($m^2s^{-4}h \times 10^3$)	median OR (95% CI)	1.1 1.0 (-)	4.0 0.617 0.300 1.270	8.9 0.800 0.400 1.597	26.9 0.742 0.362 1.517	1.7667 0.6222
$\Sigma[a_{wsi}{}^4t_i]$ ($m^4s^{-8}h \times 10^3$)	median OR (95% CI)	0.29 1.0 (-)	1.2 0.980 0.490 1.958	3.3 0.770 0.382 1.551	14.1 0.968 0.488 1.922	0.6893 0.8757
$\Sigma[a_{wqi}t_i]$ ($ms^{-2}h \times 10^3$)	median OR (95% CI)	1.95 1.0 (-)	5.60 0.687 0.334 1.414	12.16 0.771 0.370 1.605	27.73 0.950 0.453 1.991	1.4665 0.6900
$\Sigma[a_{wqi}{}^2t_i]$ ($m^2s^{-4}h \times 10^3$)	median OR (95% CI)	0.59 1.0 (-)	2.36 0.677 0.331 1.383	4.94 0.861 0.432 1.717	14.49 0.810 0.396 1.659	1.1684 0.7606
$\Sigma[a_{wqi}{}^4t_i]$ ($m^4s^{-8}h \times 10^3$)	median OR (95% CI)	0.1 1.0 (-)	0.36 0.561 0.269 1.170	0.99 0.844 0.433 1.644	4.09 0.855 0.435 1.682	2.4428 0.4857

Table 16a. Binary logistic regression of sick leave (> 7 days) due to LBP in the previous 12 months on alternative measures of daily exposure to whole-body vibration (WBV) in the professional drivers (n=230) over one-year follow-up period. Odds ratio (OR) and 95% confidence interval (95% CI) are adjusted for several covariates (Age, physical load factors, psychosocial factors, back trauma, and follow-up time). Each measure of WBV exposure was included as a quartile based design variable, assuming the lowest quartile as the reference category. The likelihood ratio (LR) test for the measures of WBV exposure is given.

Measures of daily WBV exposure		Quartiles of measure of daily WBV exposure				LR test (χ^2, 3*df*)
		Q1	Q2	Q3	Q4	
Daily driving time (h)	median	5.0	8.0	9.4	11.0	5.0075
	OR	1.0	0.697	1.243	2.418	0.1713
	(95% CI)	(-)	0.218 2.230	0.481 3.209	0.871 6.714	
$A_v(8)$ (ms^{-2} r.m.s.)	median	0.28	0.45	0.56	0.74	1.0493
	OR	1.0	0.934	1.460	1.383	0.7893
	(95% CI)	(-)	0.303 2.883	0.529 4.028	0.503 3.807	
$A_{dom}(8)$ (ms^{-2} r.m.s.)	median	0.18	0.32	0.39	0.53	3.3654
	OR	1.0	0.665	1.542	1.635	0.3386
	(95% CI)	(-)	0.216 2.043	0.544 4.368	0.598 4.468	
VDV_v ($ms^{-1.75}$)	median	3.20	4.90	6.46	11.83	3.0801
	OR	1.0	0.763	1.456	1.860	0.3794
	(95% CI)	(-)	0.226 2.576	0.492 4.310	0.689 5.021	
VDV_{dom} ($ms^{-1.75}$)	median	3.26	4.56	5.81	10.34	3.0502
	OR	1.0	0.706	1.459	1.825	0.3840
	(95% CI)	(-)	0.196 2.542	0.507 4.194	0.702 4.742	

Table 16b. Binary logistic regression of sick leave (> 7 days) due to LBP in the previous 12 months on alternative measures of cumulative exposure in most recent job, to whole-body vibration (WBV) in the professional drivers (n=230) over one-year follow-up period. Odds ratio (OR) and 95% confidence interval (95% CI) are adjusted for several covariates (Age, physical load factors, psychosocial factors, back trauma and follow-up time). Each measure of WBV exposure was included as a quartile based design variable, assuming the lowest quartile as the reference category. The likelihood ratio (LR) test for the measures of WBV exposure is given.

Measures of cumulative WBV exposure		Quartiles of measure of cumulative WBV exposure				LR test (χ^2, 3*df*)
		Q1	Q2	Q3	Q4	
Exposure duration (yr)	median	3.2	10.1	21.6	34.8	0.9207
	OR	1.0	0.614	0.658	0.699	0.8204
	(95% CI)	(-)	0.207 1.818	0.228 1.899	0.213 2.293	
$\sum[t_i]$ (h $\times 10^3$)	median	4.6	16.7	34.9	60.7	0.7180
	OR	1.0	1.432	1.027	1.014 0.289	0.8690
	(95% CI)	(-)	0.472 4.345	0.314 3.365	3.554	
$\sum[a_{wsi}t_i]$(ms^{-2}h$\times 10^3$)	median	2.8	7.7	16.4	38.2	2.0422
	OR	1.0	2.070	1.222	1.222	0.5637
	(95% CI)	(-)	0.663 6.463	0.348 4.286	0.348 4.286	
$\sum[a_{wsi}^2 t_i]$ (m^{2}s^{-4}h $\times 10^3$)	median	1.1	4.0	8.9	26.9	0.9390
	OR	1.0	1.644	1.534	1.656	0.8160
	(95% CI)	(-)	0.534 5.064	0.498 4.726	0.527 5.204	
$\sum[a_{wsi}^4 t_i]$ (m^{4}s^{-8}h $\times 10^3$)	median	0.29	1.2	3.3	14.1	2.2531
	OR	1.0	0.449	1.091	0.986	0.5216
	(95% CI)	(-)	0.132 1.532	0.417 2.857	0.369 2.632	
$\sum[a_{wqi}t_i]$ (ms^{-2}h $\times 10^3$)	median	1.95	5.60	12.16	27.73	3.4759
	OR	1.0	2.169	0.977	1.913	0.3239
	(95% CI)	(-)	0.704 6.681	0.269 3.545	0.570 6.421	
$\sum[a_{wqi}^2 t_i]$ (m^{2}s^{-4}h $\times 10^3$)	median	0.59	2.36	4.94	14.49	1.8122
	OR	1.0	1.957	2.070	2.043	0.6123
	(95% CI)	(-)	0.606 6.322	0.652 6.570	0.619 6.746	
$\sum[a_{wqi}^4 t_i]$ (m^{4}s^{-8}h $\times 10^3$)	median	0.1	0.36	0.99	4.09	3.7622
	OR	1.0	0.337	1.250	0.989	0.2883
	(95% CI)	(-)	0.087 1.307	0.486 3.217	0.367 2.667	

Table 17. Binary logistic regression of low back pain (LBP) symptoms (7-day LBP, 12-month LBP, and high pain intensity (Von Korff pain scale score ≥ 5), LBP disability (Roland & Morris disability scale score ≥ 12), treated LBP, sick leave due to LBP in the previous 12 months) on postural load index in the professional drivers over one-year follow-up period. Odds ratio (OR) and 95% confidence interval (95% CI) are adjusted for several covariates (individual characteristics, vibration exposure, psychosocial factors, back trauma, previous jobs at risk, and follow-up time). The likelihood ratio (LR) test for postural load index is given.

Outcome	Postural load index (grade)				LR test (χ^2, 3*df*)
	Score 1 (Mild)	Score 1 – 1.9 (Moderate)	Score 2 – 2.9 (Hard)	Score 3 – 4 (Very hard)	
7-day LBP OR (95% CI)	1.0 (-)	0.764 0.372 1.567	1.047 0.496 2.210	1.823 0.710 4.681	5.5504 0.1357
12-month LBP OR (95% CI)	1.0 (-)	0.819 0.422 1.586	1.259 0.623 2.541	1.530 0.591 3.960	4.8920 0.1799
Acute LBP OR (95% CI)	1.0 (-)	0.852 0.406 1.790	2.019 0.957 4.263	3.127 1.183 8.267	19.3608 0.0002
Sciatica OR (95% CI)	1.0 (-)	1.651 0.639 4.265	2.160 0.826 5.651	2.387 0.729 7.813	3.2810 0.3503
High pain intensity OR (95% CI)	1.0 (-)	0.863 0.170 4.380	3.383 0.720 15.882	2.253 0.349 14.524	10.1684 0.0172
LBP disability OR (95% CI)	1.0 (-)	1.003 0.106 9.456	1.377 0.148 12.783	5.669 0.532 60.400	5.5444 0.1360
Treated LBP OR (95% CI)	1.0 (-)	0.994 0.407 2.424	1.555 0.632 3.827	1.270 0.393 4.108	2.8609 0.4136
Sick leave due to LBP (> 7d) OR (95% CI)	1.0 (-)	1.681 0.365 7.753	1.463 0.305 7.006	3.246 0.539 19.541	2.0819 0.5556

Table 18. Random-intercept logistic regression of low back pain (LBP) symptoms (7-day LBP, 12-month LBP, and high pain intensity (Von Korff pain scale score ≥ 5), LBP disability (Roland & Morris disability scale score ≥ 12), treated LBP, sick leave due to LBP in the previous 12 months) on psychosocial load index in the professional drivers over one-year follow-up period. Odds ratio (OR) and 95% confidence interval (95% CI) are adjusted for several covariates (individual characteristics, vibration exposure, back trauma, previous jobs at risk, and follow-up time). The likelihood ratio (LR) test for postural load index is given.

Outcome	Psychosocial load index (grade)				LR test (χ^2, 2*df*)
	Score 1 (Mild)	Score 1 – 1.9 (Moderate)	Score 2 – 2.9 (Normal)	Score 3 – 3.9 (Hard)	
7-day LBP OR (95% CI)	1.0 (-)	1.281 0.773 2.123	1.345 0.562 3.218	-	0.9864 0.6107
12-month LBP OR (95% CI)	1.0 (-)	1.508 0.925 2.459	1.796 0.715 4.507	-	3.0971 0.2126
Acute LBP OR (95% CI)	1.0 (-)	1.815 1.030 3.198	2.849 1.144 7.097	-	6.1664 0.0458
Sciatica OR (95% CI)	1.0 (-)	1.021 0.547 1.907	1.986 0.741 5.323	-	2.3798 0.3043
High pain intensity OR (95% CI)	1.0 (-)	1.099 0.413 2.922	1.981 0.469 8.371	-	1.0193 0.6007
LBP disability OR (95% CI)	1.0 (-)	1.090 0.510 2.329	3.777 1.070 13.332	-	5.1458 0.0763
Treated LBP OR (95% CI)	1.0 (-)	0.838 0.456 1.541	2.672 1.060 6.735	-	7.9332 0.0189
Sick leave due to LBP (> 7d) OR (95% CI)	1.0 (-)	1.061 0.412 2.730	1.176 0.263 5.262	-	0.0452 0.9777

Table 19

Adjusted estimates of the odds ratio (OR) and 95% confidence interval (95% CI) for low back pain (LBP) in the previous 12 months and disability (Roland & Morris disability scale score ≥ 12) during the last episode of LBP in the professional drivers according to work-related physical load variables.

Variable		12-month LBP OR (95% CI)		LBP disability OR (95% CI)	
Walking & standing at work	never	1.0 (-)		1.0 (-)	
	<1 h/d	1,308	,672 2,547	1,166	,224 6,074
	1-3 h/d	1,136	,677 1,906	1,069	,291 3,928
	>3 h/d	1,068	,674 1,694	1,714	,584 5,029
Trunk bent 20° to 40°	never	1.0 (-)		1.0 (-)	
	<1 h/d	1,846	,942 3,619	2,533	,647 9,926
	1-2 h/d	2,458	1,307 4,624	2,200	,656 7,374
	>2 h/d	1,195	,628 2,271	3,298	,971 11,199
Trunk bent > 40°	never	1.0 (-)		1.0 (-)	
	<0.5 h/d	2,113	1,166 3,830	4,036	1,332 12,229
	0.5-2 h/d	1,511	,853 2,677	1,445	,382 5,476
	>2 h/d	1,443	,556 3,743	4,246	,834 21,608
Trunk twisted & bent 20° to 40°	never	1.0 (-)		1.0 (-)	
	<1 h/d	1,261	,722 2,200	1,102	,230 5,287
	1-2 h/d	1,169	,644 2,124	3,302	1,050 10,382
	>2 h/d	1,224	,637 2,351	3,937	1,231 12,589
Trunk twisted & bent > 40°	never	1.0 (-)		1.0 (-)	
	<0.5 h/d	,987	,585 1,664	1,479	,386 5,670
	0.5-2 h/d	1,791	,996 3,221	3,925	1,387 11,105
	>2 h/d	1,066	,418 2,719	3,650	,709 18,775
Arms raised & hands above shoulders	never	1.0 (-)		1.0 (-)	
	<1 h/d	,942	,588 1,509	1,369	,478 3,918
	1-3 h/d	,588	,241 1,437	-	
	>3 h/d	-		5,150	,530 50,070
Lifting loads >15 kg	never	1.0 (-)		1.0 (-)	
	1-15 min/d	1,967	1,240	2,923	,770

			3,122		11,089
	15-45 min/d	2,694	1,501 4,836	2,345	,506 10,860
	> 45 min/d	1,025	,508 2,069	5,786	1,198 27,955
Back bent forward or twisted while driving	never	1.0 (-)		1.0 (-)	
	seldom	1,120	,721 1,741	1,110	,400 3,078
	often	,932	,581 1,495	,962	,310 2,981
Physical load index (grade)	mild	1.0 (-)		1.0 (-)	
	moderate	1,065	,544 2,085	,874	,099 7,743
	hard	2,087	1,031 4,222	2,901	,360 23,358
	very hard	2,134	,831 5,484	,874	,556 50,512

Appendix Tables 2

Table 1a. Logistic regression within the transition model of low back pain in the previous 7 days on alternative measures of daily exposure to whole-body vibration (WBV) in the professional drivers (n=230) over one-year follow-up period. Odds ratio (OR) and 95% confidence interval (95% CI) are adjusted for several covariates (Age, physical load factors, psychosocial factors). Each measure of WBV exposure was included as a quartile based design variable, assuming the lowest quartile as the reference category. The likelihood ratio (LR) test for the measures of WBV exposure is given.

Measures of daily WBV exposure		Quartiles of measure of daily WBV exposure							LR test (χ^2, 3*df*)
		Q1	Q2		Q3		Q4		
Daily driving time (h)	median	5.0	8.0		9.4		11.0		4.3961
OR		1.0	1.090		1.620		1.527		0.2217
	(95% CI)	(-)	0.622	1.909	0.959	2.738	0.787	2.962	
$A_v(8)$ (ms^{-2} r.m.s.)	median	0.28	0.45		0.56		0.74		1.7620
	OR	1.0	0.845		0.683		0.859		0.6232
	(95% CI)	(-)	0.481	1.487	0.388	1.202	0.496	1.490	
$A_{dom}(8)$ (ms^{-2} r.m.s.)	median	0.18	0.32		0.39		0.53		3.0630
	OR	1.0	1.043		0.646		0.841		0.3820
	(95% CI)	(-)	0.612	1.777	0.353	1.184	0.474	1.491	
VDV_v (ms$^{-1.75}$)	median	3.20	4.90		6.46		11.83		6.5155
	OR	1.0	0.754		0.506		0.979		0.0891
	(95% CI)	(-)	0.430	1.322	0.282	0.909	0.567	1.689	
VDV_{dom} (ms$^{-1.75}$)	median	3.26	4.56		5.81		10.34		5.1842
	OR	1.0	1.096		0.612		1.134		0.1588
	(95% CI)	(-)	0.616	1.950	0.349	1.072	0.672	1.913	

Table 1b. Logistic regression within the transition model of low back pain in the previous 7 days on alternative measures of cumulative exposure in most recent job, to whole-body vibration (WBV) in the professional drivers (n=230) over one-year follow-up period. Odds ratio (OR) and 95% confidence interval (95% CI) are adjusted for several covariates (Age, physical load factors, psychosocial factors, back trauma and follow-up time). Each measure of WBV exposure was included as a quartile based design variable, assuming the lowest quartile as the reference category. The likelihood ratio (LR) test for the measures of WBV exposure is given. The likelihood ratio (LR) test for the measures of WBV exposure is given.

Measures of cumulative WBV exposure		Quartiles of measure of cumulative WBV exposure				LR test (χ^2, 3*df*)
		Q1	Q2	Q3	Q4	
Exposure duration (yr)	median	3.2	10.1	21.6	34.8	3.6008
	OR	1.0	0.856	1.452	1.025	0.3079
	(95% CI)	(-)	0.479 1.528	0.802 2.626	0.508 2.066	
$\sum[t_i]$ (h $\times 10^3$)	median	4.6	16.7	34.9	60.7	5.4786
	OR	1.0	1.111	1.833	1.868	0.1399
	(95% CI)	(-)	0.612 2.018	0.985 3.412	0.937 3.724	
$\sum[a_{wsi}t_i]$(ms^{-2}h$\times 10^3$)	median	2.8	7.7	16.4	38.2	2.9929
	OR	1.0	1.057	1.025	1.597	0.3927
	(95% CI)	(-)	0.590 1.896	0.559 1.878	0.833 3.062	
$\sum[a_{wsi}^2 t_i]$ (m^{2}s^{-4}h $\times 10^3$)	median	1.1	4.0	8.9	26.9	3.9810
	OR	1.0	0.812	0.651	1.115	0.2635
	(95% CI)	(-)	0.461 1.431	0.360 1.175	0.613 2.028	
$\sum[a_{wsi}^4 t_i]$ (m^{4}s^{-8}h $\times 10^3$)	median	0.29	1.2	3.3	14.1	5.8866
	OR	1.0	0.517	0.747	0.939	0.1173
	(95% CI)	(-)	0.290 0.921	0.428 1.303	0.533 1.655	
$\sum[a_{wqi}t_i]$ (ms^{-2}h $\times 10^3$)	median	1.95	5.60	12.16	27.73	7.1330
	OR	1.0	0.798	0.818	1.609	0.0678
	(95% CI)	(-)	0.447 1.423	0.447 1.497	0.860 3.010	
$\sum[a_{wqi}^2 t_i]$ (m^{2}s^{-4}h $\times 10^3$)	median	0.59	2.36	4.94	14.49	3.5319
	OR	1.0	0.819	0.704	1.171	0.3166
	(95% CI)	(-)	0.465 1.442	0.392 1.263	0.646 2.123	
$\sum[a_{wqi}^4 t_i]$ (m^{4}s^{-8}h $\times 10^3$)	median	0.1	0.36	0.99	4.09	5.5787
	OR	1.0	0.523	0.790	0.944	0.1340
	(95% CI)	(-)	0.292 0.937	0.452 1.382	0.534 1.668	

Table 2a. Logistic regression within the transition model of low back pain in the previous 12 months on alternative measures of daily exposure to whole-body vibration (WBV) in the professional drivers (n=230) over one-year follow-up period. Odds ratio (OR) and 95% confidence interval (95% CI) are adjusted for several covariates (Age, physical load factors, psychosocial factors, back trauma, and follow-up time). Each measure of WBV exposure was included as a quartile based design variable, assuming the lowest quartile as the reference category. The likelihood ratio (LR) test for the measures of WBV exposure is given. The likelihood ratio (LR) test for the measures of WBV exposure is given.

Measures of daily WBV exposure		Quartiles of measure of daily WBV exposure				LR test (χ^2, 3*df*)
		Q1	Q2	Q3	Q4	
Daily driving time (h)	median OR (95% CI)	5.0 1.0 (-)	8.0 0.865 0.503 1.487	9.4 1.232 0.729 2.083	11.0 1.740 0.867 3.493	4.6761 0.1971
$A_v(8)$ (ms^{-2} r.m.s.)	median OR (95% CI)	0.28 1.0 (-)	0.45 0.855 0.482 1.517	0.56 0.732 0.414 1.295	0.74 0.711 0.407 1.242	1.8012 0.6147
$A_{dom}(8)$ (ms^{-2} r.m.s.)	median OR (95% CI)	0.18 1.0 (-)	0.32 0.910 0.527 1.572	0.39 0.723 0.398 1.314	0.53 0.782 0.439 1.392	1.4447 0.6951
VDV_v ($ms^{-1.75}$)	median OR (95% CI)	3.20 1.0 (-)	4.90 0.488 0.276 0.863	6.46 0.669 0.377 1.190	11.83 0.853 0.482 1.510	6.9244 0.0743
VDV_{dom} ($ms^{-1.75}$)	median OR (95% CI)	3.26 1.0 (-)	4.56 0.851 0.476 1.521	5.81 0.843 0.495 1.436	10.34 1.163 0.682 1.982	1.5650 0.6673

Table 2b. Logistic regression within the transition model of low back pain in the previous 12 months on alternative measures of cumulative exposure in most recent job, to whole-body vibration (WBV) in the professional drivers (n=230) over one-year follow-up period. Odds ratio (OR) and 95% confidence interval (95% CI) are adjusted for several covariates (Age, marital status, physical load factors, psychosocial factors, back trauma and follow-up time). Each measure of WBV exposure was included as a quartile based design variable, assuming the lowest quartile as the reference category. The likelihood ratio (LR) test for the measures of WBV exposure is given.

Measures of cumulative WBV exposure		Quartiles of measure of cumulative WBV exposure				LR test (χ^2, 3*df*)
		Q1	Q2	Q3	Q4	
Exposure duration (yr)	median	3.2	10.1	21.6	34.8	0.7908
	OR	1.0	0.898	1.151	1.112	0.8517
	(95% CI)	(-)	0.506 1.593	0.627 2.114	0.557 2.217	
$\sum[t_i]$ (h $\times 10^3$)	median	4.6	16.7	34.9	60.7	4.3123
	OR	1.0	1.184	1.881	1.459	0.2297
	(95% CI)	(-)	0.665 2.110	1.012 3.498	0.745 2.855	
$\sum[a_{wsi}t_i]$($ms^{-2}h\times 10^3$)	median	2.8	7.7	16.4	38.2	0.3181
	OR	1.0	1.126	0.961	1.037	0.9566
	(95% CI)	(-)	0.625 2.030	0.533 1.733	0.542 1.985	
$\sum[a_{wsi}^2 t_i]$ ($m^2s^{-4}h \times 10^3$)	median	1.1	4.0	8.9	26.9	0.8210
	OR	1.0	1.017	1.063	0.829	0.8444
	(95% CI)	(-)	0.571 1.812	0.591 1.910	0.446 1.539	
$\sum[a_{wsi}^4 t_i]$ ($m^4s^{-8}h \times 10^3$)	median	0.29	1.2	3.3	14.1	1.6499
	OR	1.0	0.754	1.065	0.898	0.6481
	(95% CI)	(-)	0.429 1.327	0.600 1.891	0.500 1.611	
$\sum[a_{wqi}t_i]$ ($ms^{-2}h \times 10^3$)	median	1.95	5.60	12.16	27.73	0.5756
	OR	1.0	1.106	0.939	1.143	0.9020
	(95% CI)	(-)	0.619 1.978	0.523 1.689	0.605 2.162	
$\sum[a_{wqi}^2 t_i]$ ($m^2s^{-4}h \times 10^3$)	median	0.59	2.36	4.94	14.49	1.0183
	OR	1.0	0.946	1.175	0.888	0.7968
	(95% CI)	(-)	0.533 1.679	0.655 2.107	0.480 1.643	
$\sum[a_{wqi}^4 t_i]$ ($m^4s^{-8}h \times 10^3$)	median	0.1	0.36	0.99	4.09	3.7997
	OR	1.0	0.698	1.187	0.828	0.2839
	(95% CI)	(-)	0.396 1.232	0.661 2.130	0.458 1.495	

Table 3a. Logistic regression within the transition model of acute low back pain in the previous 12 months on alternative measures of daily exposure to whole-body vibration (WBV) in the professional drivers (n=230) over one-year follow-up period. Odds ratio (OR) and 95% confidence interval (95% CI) are adjusted for several covariates (Age, previous jobs at risk, physical load factors, psychosocial factors, back trauma, and follow-up time). Each measure of WBV exposure was included as a quartile based design variable, assuming the lowest quartile as the reference category. The likelihood ratio (LR) test for the measures of WBV exposure is given.

Measures of daily WBV exposure		Quartiles of measure of daily WBV exposure				LR test (χ^2, 3*df*)
		Q1	Q2	Q3	Q4	
Daily driving time (h)	median	5.0	8.0	9.4	11.0	8.1445
	OR	1.0	1.416	2.062	2.139	0.0431
	(95% CI)	(-)	0.782 2.564	1.186 3.584	1.066 4.293	
$A_v(8)$ (ms^{-2} r.m.s.)	median	0.28	0.45	0.56	0.74	2.0904
	OR	1.0	1.355	0.935	1.257	0.5539
	(95% CI)	(-)	0.754 2.435	0.512 1.707	0.697 2.269	
$A_{dom}(8)$ (ms^{-2} r.m.s.)	median	0.18	0.32	0.39	0.53	2.6108
	OR	1.0	1.078	0.738	1.228	0.4556
	(95% CI)	(-)	0.616 1.888	0.389 1.400	0.673 2.241	
VDV_v ($ms^{-1.75}$)	median	3.20	4.90	6.46	11.83	1.8133
	OR	1.0	0.743	0.938	1.102	0.6121
	(95% CI)	(-)	0.407 1.356	0.517 1.703	0.611 1.986	
VDV_{dom} ($ms^{-1.75}$)	median	3.26	4.56	5.81	10.34	2.1004
	OR	1.0	0.833	1.034	1.317	0.5518
	(95% CI)	(-)	0.447 1.553	0.587 1.822	0.753 2.303	

Table 3b. Logistic regression within the transition model of acute low back pain in the previous 12 months on alternative measures of cumulative exposure in most recent job, to whole-body vibration (WBV) in the professional drivers (n=230) over one-year follow-up period. Odds ratio (OR) and 95% confidence interval (95% CI) are adjusted for several covariates (Age, physical load factors, psychosocial factors, back trauma and follow-up time). Each measure of WBV exposure was included as a quartile based design variable, assuming the lowest quartile as the reference category. The likelihood ratio (LR) test for the measures of WBV exposure is given.

Measures of cumulative WBV exposure		Quartiles of measure of cumulative WBV exposure				LR test (χ^2, 3*df*)
		Q1	Q2	Q3	Q4	
Exposure duration (yr)	median OR (95% CI)	3.2 1.0 (-)	10.1 1.325 0.732 2.396	21.6 1.742 0.934 3.251	34.8 1.639 0.780 3.443	3.1595 0.3677
$\Sigma[t_i]$ (h $\times 10^3$)	median OR (95% CI)	4.6 1.0 (-)	16.7 1.859 1.003 3.443	34.9 2.138 1.103 4.146	60.7 3.235 1.545 6.773	9.8462 0.0199
$\Sigma[a_{wsi}t_i]$($ms^{-2}h \times 10^3$)	median OR (95% CI)	2.8 1.0 (-)	7.7 1.564 0.853 2.865	16.4 1.312 0.698 2.467	38.2 2.300 1.149 4.603	6.1142 0.1062
$\Sigma[a_{wsi}^2 t_i]$ ($m^2s^{-4}h \times 10^3$)	median OR (95% CI)	1.1 1.0 (-)	4.0 1.649 0.906 3.001	8.9 1.368 0.743 2.520	26.9 2.032 1.064 3.878	5.1376 0.1620
$\Sigma[a_{wsi}^4 t_i]$ ($m^4s^{-8}h \times 10^3$)	median OR (95% CI)	0.29 1.0 (-)	1.2 1.048 0.584 1.879	3.3 1.189 0.664 2.131	14.1 1.360 0.743 2.488	1.1722 0.7597
$\Sigma[a_{wqi}t_i]$ ($ms^{-2}h \times 10^3$)	median OR (95% CI)	1.95 1.0 (-)	5.60 1.876 1.022 3.442	12.16 1.427 0.749 2.719	27.73 3.128 1.575 6.214	12.0904 0.0071
$\Sigma[a_{wqi}^2 t_i]$ ($m^2s^{-4}h \times 10^3$)	median OR (95% CI)	0.59 1.0 (-)	2.36 1.871 1.027 3.410	4.94 1.406 0.761 2.597	14.49 2.348 1.229 4.485	7.7704 0.0510
$\Sigma[a_{wqi}^4 t_i]$ ($m^4s^{-8}h \times 10^3$)	median OR (95% CI)	0.1 1.0 (-)	0.36 0.867 0.479 1.569	0.99 1.307 0.734 2.329	4.09 1.297 0.711 2.368	2.5346 0.4691

Table 4a. Logistic regression within the transition model of sciatica in the previous 12 months on alternative measures of daily exposure to whole-body vibration (WBV) in the professional drivers (n=230) over one-year follow-up period. Odds ratio (OR) and 95% confidence interval (95% CI) are adjusted for several covariates (Age, BMI, marital status, physical load factors, psychosocial factors, back trauma, and follow-up time). Each measure of WBV exposure was included as a quartile based design variable, assuming the lowest quartile as the reference category. The likelihood ratio (LR) test for the measures of WBV exposure is given.

Measures of daily WBV exposure		Quartiles of measure of daily WBV exposure				LR test (χ^2, 3*df*)
		Q1	Q2	Q3	Q4	
Daily driving time (h)	median	5.0	8.0	9.4	11.0	7.1844
	OR	1.0	0.759	1.712	1.484	0.0662
	(95% CI)	(-)	0.374 1.540	0.925 3.171	0.685 3.213	
$A_v(8)$ (ms^{-2} r.m.s.)	median	0.28	0.45	0.56	0.74	0.6531
	OR	1.0	1.038	0.928	0.796	0.8842
	(95% CI)	(-)	0.538 2.002	0.478 1.801	0.402 1.576	
$A_{dom}(8)$ (ms^{-2} r.m.s.)	median	0.18	0.32	0.39	0.53	0.6263
	OR	1.0	1.251	1.035	1.036	0.8904
	(95% CI)	(-)	0.661 2.370	0.505 2.119	0.510 2.105	
VDV_v ($ms^{-1.75}$)	median	3.20	4.90	6.46	11.83	3.5744
	OR	1.0	0.879	0.748	1.393	0.3112
	(95% CI)	(-)	0.442 1.748	0.372 1.504	0.722 2.691	
VDV_{dom} ($ms^{-1.75}$)	median	3.26	4.56	5.81	10.34	4.1254
	OR	1.0	0.886	0.732	1.449	0.2482
	(95% CI)	(-)	0.433 1.814	0.373 1.436	0.781 2.688	

Table 4b. Logistic regression within the transition model of sciatica in the previous 12 months on alternative measures of cumulative exposure in most recent job, to whole-body vibration (WBV) in the professional drivers (n=230) over one-year follow-up period. Odds ratio (OR) and 95% confidence interval (95% CI) are adjusted for several covariates (Age, BMI, physical load factors, psychosocial factors, back trauma and follow-up time). Each measure of WBV exposure was included as a quartile based design variable, assuming the lowest quartile as the reference category. The likelihood ratio (LR) test for the measures of WBV exposure is given.

Measures of cumulative WBV exposure		Quartiles of measure of cumulative WBV exposure				LR test (χ^2, 3*df*)
		Q1	Q2	Q3	Q4	
Exposure duration (yr)	median	3.2	10.1	21.6	34.8	2.8399
	OR	1.0	0.578	0.914	1.012	0.4170
	(95% CI)	(-)	0.279 1.199	0.458 1.825	0.461 2.218	
$\sum[t_i]$ (h $\times 10^3$)	median	4.6	16.7	34.9	60.7	6.9759
	OR	1.0	0.881	1.946	1.969	0.0727
	(95% CI)	(-)	0.406 1.913	0.922 4.109	0.875 4.434	
$\sum[a_{wsi}t_i]$($ms^{-2}h\times 10^3$)	median	2.8	7.7	16.4	38.2	3.0420
	OR	1.0	1.679	1.368	1.905	0.3852
	(95% CI)	(-)	0.810 3.481	0.640 2.923	0.865 4.193	
$\sum[a_{wsi}^2t_i]$ ($m^2s^{-4}h \times 10^3$)	median	1.1	4.0	8.9	26.9	2.3392
	OR	1.0	1.507	0.949	1.260	0.5051
	(95% CI)	(-)	0.764 2.971	0.467 1.929	0.611 2.598	
$\sum[a_{wsi}^4t_i]$ ($m^4s^{-8}h \times 10^3$)	median	0.29	1.2	3.3	14.1	0.7362
	OR	1.0	0.775	0.805	0.925	0.8646
	(95% CI)	(-)	0.395 1.519	0.416 1.556	0.473 1.809	
$\sum[a_{wqi}t_i]$ ($ms^{-2}h \times 10^3$)	median	1.95	5.60	12.16	27.73	2.8414
	OR	1.0	1.497	1.224	1.819	0.4167
	(95% CI)	(-)	0.732 3.059	0.580 2.583	0.850 3.895	
$\sum[a_{wqi}^2t_i]$ ($m^2s^{-4}h \times 10^3$)	median	0.59	2.36	4.94	14.49	3.3817
	OR	1.0	1.569	0.993	1.582	0.3364
	(95% CI)	(-)	0.791 3.111	0.482 2.045	0.767 3.263	
$\sum[a_{wqi}^4t_i]$ ($m^4s^{-8}h \times 10^3$)	median	0.1	0.36	0.99	4.09	0.6840
	OR	1.0	0.844	1.116	1.057	0.8770
	(95% CI)	(-)	0.423 1.684	0.578 2.157	0.533 2.097	

Table 5a. Logistic regression within the transition model of high pain intensity in the lower back (von korff pain scale > 5) on alternative measures of daily exposure to whole-body vibration (WBV) in the professional drivers (n=230) over one-year follow-up period. Odds ratio (OR) and 95% confidence interval (95% CI) are adjusted for several covariates (Age, smoking, physical load factors, psychosocial factors, back trauma, and follow-up time). Each measure of WBV exposure was included as a quartile based design variable, assuming the lowest quartile as the reference category. The likelihood ratio (LR) test for the measures of WBV exposure is given.

Measures of daily WBV exposure		Quartiles of measure of daily WBV exposure				LR test (χ^2, 3*df*)
		Q1	Q2	Q3	Q4	
Daily driving time (h)	median	5.0	8.0	9.4	11.0	9.8237
	OR	1.0	1.444	3.313	0.780	0.0201
	(95% CI)	(-)	0.484 4.309	1.331 8.245	0.208 2.932	
$A_v(8)$ (ms^{-2} r.m.s.)	median	0.28	0.45	0.56	0.74	2.9566
	OR	1.0	0.484	0.522	0.626	0.3984
	(95% CI)	(-)	0.183 1.279	0.206 1.327	0.240 1.635	
$A_{dom}(8)$ (ms^{-2} r.m.s.)	median	0.18	0.32	0.39	0.53	1.7758
	OR	1.0	1.119	0.544	0.844	0.6202
	(95% CI)	(-)	0.469 2.669	0.173 1.713	0.307 2.326	
VDV_v ($ms^{-1.75}$)	median	3.20	4.90	6.46	11.83	0.8149
	OR	1.0	0.942	0.658	0.785	0.8459
	(95% CI)	(-)	0.374 2.374	0.241 1.799	0.295 2.088	
VDV_{dom} ($ms^{-1.75}$)	median	3.26	4.56	5.81	10.34	0.5846
	OR	1.0	1.027	0.712	0.946	0.8999
	(95% CI)	(-)	0.391 2.694	0.265 1.916	0.373 2.394	

Table 5b. Logistic regression within the transition model of high pain intensity in the lower back (von Korff pain scale > 5) on alternative measures of cumulative exposure in most recent job, to whole-body vibration (WBV) in the professional drivers (n=230) over one-year follow-up period. Odds ratio (OR) and 95% confidence interval (95% CI) are adjusted for several covariates (Age, smoking, physical load factors, psychosocial factors, back trauma and follow-up time). Each measure of WBV exposure was included as a quartile based design variable, assuming the lowest quartile as the reference category. The likelihood ratio (LR) test for the measures of WBV exposure is given.

Measures of cumulative WBV exposure		Quartiles of measure of cumulative WBV exposure							LR test (χ^2, 3*df*)
		Q1	Q2		Q3		Q4		
Exposure duration (yr)	median	3.2	10.1		21.6		34.8		4.4391
	OR	1.0	0.330		0.579		0.913		0.2178
	(95% CI)	(-)	0.099	1.101	0.205	1.636	0.292	2.850	
$\Sigma[t_i]$ (h $\times 10^3$)	median	4.6	16.7		34.9		60.7		4.5392
	OR	1.0	0.472		1.437		1.569		0.2088
	(95% CI)	(-)	0.130	1.712	0.461	4.475	0.462	5.322	
$\Sigma[a_{wsi}t_i]$(ms^{-2}h$\times 10^3$)	median	2.8	7.7		16.4		38.2		2.0750
	OR	1.0	0.701		0.428		0.742		0.5570
	(95% CI)	(-)	0.252	1.948	0.130	1.408	0.246	2.238	
$\Sigma[a_{wsi}^2t_i]$ (m^{2}s^{-4}h $\times 10^3$)	median	1.1	4.0		8.9		26.9		4.3795
	OR	1.0	0.521		0.335		0.509		0.2233
	(95% CI)	(-)	0.194	1.404	0.117	0.964	0.186	1.397	
$\Sigma[a_{wsi}^4t_i]$ (m^{4}s^{-8}h $\times 10^3$)	median	0.29	1.2		3.3		14.1		5.6969
	OR	1.0	0.325		0.409		0.564		0.1273
	(95% CI)	(-)	0.108	0.972	0.158	1.058	0.222	1.432	
$\Sigma[a_{wqi}t_i]$ (ms^{-2}h $\times 10^3$)	median	1.95	5.60		12.16		27.73		1.7112
	OR	1.0	0.644		0.504		0.808		0.6344
	(95% CI)	(-)	0.230	1.805	0.163	1.552	0.277	2.358	
$\Sigma[a_{wqi}^2t_i]$ (m^{2}s^{-4}h $\times 10^3$)	median	0.59	2.36		4.94		14.49		2.4707
	OR	1.0	0.610		0.444		0.612		0.4806
	(95% CI)	(-)	0.230	1.622	0.158	1.249	0.223	1.681	
$\Sigma[a_{wqi}^4t_i]$ (m^{4}s^{-8}h $\times 10^3$)	median	0.1	0.36		0.99		4.09		3.5964
	OR	1.0	0.443		0.462		0.613		0.3085
	(95% CI)	(-)	0.155	1.261	0.177	1.205	0.239	1.574	

Table 6a. Logistic regression within the transition model of disability (Roland & Morris disability scale score≥ 12) during the last episode of LBP on alternative measures of daily exposure to whole-body vibration (WBV) in the professional drivers (n=230) over one-year follow-up period. Odds ratio (OR) and 95% confidence interval (95% CI) are adjusted for several covariates (Age, physical load factors, psychosocial factors, back trauma, and follow-up time). Each measure of WBV exposure was included as a quartile based design variable, assuming the lowest quartile as the reference category. The likelihood ratio (LR) test for the measures of WBV exposure is given.

Measures of daily WBV exposure		Quartiles of measure of daily WBV exposure							LR test (χ^2, 3*df*)
		Q1	Q2		Q3		Q4		
Daily driving time (h)	median	5.0	8.0		9.4		11.0		4.9624
	OR	1.0	3.635		5.949		4.065		0.1746
	(95% CI)	(-)	0.657	20.100	1.220	29.005	0.686	24.072	
$A_v(8)$ (ms^{-2} r.m.s.)	median	0.28	0.45		0.56		0.74		6.8887
	OR	1.0	0.269		0.239		0.396		0.0755
	(95% CI)	(-)	0.069	1.041	0.062	0.915	0.117	1.344	
$A_{dom}(8)$ (ms^{-2} r.m.s.)	median	0.18	0.32		0.39		0.53		3.2439
	OR	1.0	0.404		0.399		0.490		0.3555
	(95% CI)	(-)	0.124	1.314	0.101	1.579	0.139	1.722	
VDV_v ($ms^{-1.75}$)	median	3.20	4.90		6.46		11.83		2.2412
	OR	1.0	0.349		0.664		0.620		0.5239
	(95% CI)	(-)	0.086	1.421	0.194	2.276	0.186	2.070	
VDV_{dom} ($ms^{-1.75}$)	median	3.26	4.56		5.81		10.34		2.3877
	OR	1.0	0.291		0.759		0.639		0.4959
	(95% CI)	(-)	0.058	1.461	0.230	2.500	0.198	2.070	

Table 6b. Logistic regression within the transition model of disability (Roland & Morris disability scale score≥ 12) during the last episode of LBP on alternative measures of cumulative exposure in most recent job, to whole-body vibration (WBV) in the professional drivers (n=230) over one-year follow-up period. Odds ratio (OR) and 95% confidence interval (95% CI) are adjusted for several covariates (Age, previous jobs at risks, physical load factors, psychosocial factors, back trauma and follow-up time). Each measure of WBV exposure was included as a quartile based design variable, assuming the lowest quartile as the reference category. The likelihood ratio (LR) test for the measures of WBV exposure is given.

Measures of cumulative WBV exposure		Quartiles of measure of cumulative WBV exposure				LR test (χ^2, 3*df*)
		Q1	Q2	Q3	Q4	
Exposure duration (yr)	median OR (95% CI)	3.2 1.0 (-)	10.1 5.199 0.574 47.060	21.6 4.501 0.503 40.286	34.8 4.860 0.460 51.292	2.2155 0.5289
$\sum[t_i]$ (h $\times 10^3$)	median OR (95% CI)	4.6 1.0 (-)	16.7 -	34.9 -	60.7 -	-
$\sum[a_{wsi}t_i]$(ms^{-2}h$\times 10^3$)	median OR (95% CI)	2.8 1.0 (-)	7.7 4.052 0.816 20.116	16.4 0.658 0.095 4.539	38.2 0.986 0.165 5.875	9.3948 0.0245
$\sum[a_{wsi}^2 t_i]$ (m^{2}s^{-4}h $\times 10^3$)	median OR (95% CI)	1.1 1.0 (-)	4.0 0.730 0.214 2.485	8.9 0.238 0.054 1.046	26.9 0.440 0.120 1.608	4.0976 0.2511
$\sum[a_{wsi}^4 t_i]$ (m^{4}s^{-8}h $\times 10^3$)	median OR (95% CI)	0.29 1.0 (-)	1.2 0.134 0.026 0.690	3.3 0.185 0.046 0.741	14.1 0.321 0.095 1.078	9.7123 0.0212
$\sum[a_{wqi}t_i]$ (ms^{-2}h $\times 10^3$)	median OR (95% CI)	1.95 1.0 (-)	5.60 9.876 1.185 82.332	12.16 1.991 0.200 19.783	27.73 2.470 0.262 23.272	9.9573 0.0189
$\sum[a_{wqi}^2 t_i]$ (m^{2}s^{-4}h $\times 10^3$)	median OR (95% CI)	0.59 1.0 (-)	2.36 0.737 0.211 2.580	4.94 0.464 0.119 1.816	14.49 0.587 0.159 2.177	1.3474 0.7179
$\sum[a_{wqi}^4 t_i]$ (m^{4}s^{-8}h $\times 10^3$)	median OR (95% CI)	0.1 1.0 (-)	0.36 0.277 0.068 1.135	0.99 0.235 0.059 0.944	4.09 0.408 0.121 1.371	5.9957 0.1118

Table 7a. Logistic regression within the transition model of treated LBP in the previous 12 months on alternative measures of daily exposure to whole-body vibration (WBV) in the professional drivers (n=230) over one-year follow-up period. Odds ratio (OR) and 95% confidence interval (95% CI) are adjusted for several covariates (Age, physical load factors, psychosocial factors, back trauma, and follow-up time). Each measure of WBV exposure was included as a quartile based design variable, assuming the lowest quartile as the reference category. The likelihood ratio (LR) test for the measures of WBV exposure is given.

Measures of daily WBV exposure		Quartiles of measure of daily WBV exposure				LR test (χ^2, 3*df*)
		Q1	Q2	Q3	Q4	
Daily driving time (h)	median	5.0	8.0	9.4	11.0	8.7005
	OR	1.0	1.282	2.252	2.611	0.0335
	(95% CI)	(-)	0.607 2.706	1.148 4.419	1.163 5.861	
$A_v(8)$ (ms^{-2} r.m.s.)	median	0.28	0.45	0.56	0.74	0.7607
	OR	1.0	0.730	0.897	0.886	0.8589
	(95% CI)	(-)	0.359 1.487	0.454 1.775	0.450 1.744	
$A_{dom}(8)$ (ms^{-2} r.m.s.)	median	0.18	0.32	0.39	0.53	1.4270
	OR	1.0	0.915	0.657	1.009	0.6992
	(95% CI)	(-)	0.476 1.758	0.304 1.422	0.506 2.010	
VDV_v (ms$^{-1.75}$)	median	3.20	4.90	6.46	11.83	2.1043
	OR	1.0	0.679	1.005	1.143	0.5510
	(95% CI)	(-)	0.326 1.413	0.500 2.018	0.585 2.234	
VDV_{dom} (ms$^{-1.75}$)	median	3.26	4.56	5.81	10.34	1.9294
	OR	1.0	0.872	1.076	1.422	0.5872
	(95% CI)	(-)	0.411 1.852	0.541 2.139	0.747 2.708	

Table 7b. Logistic regression within the transition model of treated LBP in the previous 12 months on alternative measures of cumulative exposure in most recent job, to whole-body vibration (WBV) in the professional drivers (n=230) over one-year follow-up period. Odds ratio (OR) and 95% confidence interval (95% CI) are adjusted for several covariates (Age, physical load factors, psychosocial factors, back trauma and follow-up time). Each measure of WBV exposure was included as a quartile based design variable, assuming the lowest quartile as the reference category. The likelihood ratio (LR) test for the measures of WBV exposure is given.

Measures of cumulative WBV exposure		Quartiles of measure of cumulative WBV exposure				LR test (χ^2, 3*df*)
		Q1	Q2	Q3	Q4	
Exposure duration (yr)	median	3.2	10.1	21.6	34.8	1.8534
	OR	1.0	0.608	0.773	0.860	0.6034
	(95% CI)	(-)	0.287 1.289	0.371 1.611	0.371 1.994	
$\Sigma[t_i]$ (h $\times 10^3$)	median	4.6	16.7	34.9	60.7	2.2109
	OR	1.0	0.947	1.529	1.433	0.5298
	(95% CI)	(-)	0.430 2.085	0.697 3.352	0.605 3.399	
$\Sigma[a_{wsi}t_i]$(ms^{-2}h$\times 10^3$)	median	2.8	7.7	16.4	38.2	0.3296
	OR	1.0	1.126	1.156	1.269	0.9544
	(95% CI)	(-)	0.532 2.385	0.530 2.521	0.561 2.873	
$\Sigma[a_{wsi}^2 t_i]$ (m^{2}s^{-4}h $\times 10^3$)	median	1.1	4.0	8.9	26.9	1.4395
	OR	1.0	0.645	0.768	0.763	0.6963
	(95% CI)	(-)	0.311 1.337	0.381 1.547	0.366 1.588	
$\Sigma[a_{wsi}^4 t_i]$ (m^{4}s^{-8}h $\times 10^3$)	median	0.29	1.2	3.3	14.1	0.4286
	OR	1.0	0.919	0.809	0.984	0.9343
	(95% CI)	(-)	0.456 1.852	0.399 1.640	0.490 1.979	
$\Sigma[a_{wqi}t_i]$ (ms^{-2}h $\times 10^3$)	median	1.95	5.60	12.16	27.73	1.3971
	OR	1.0	0.708	0.794	1.004	0.7062
	(95% CI)	(-)	0.341 1.471	0.376 1.675	0.470 2.144	
$\Sigma[a_{wqi}^2 t_i]$ (m^{2}s^{-4}h $\times 10^3$)	median	0.59	2.36	4.94	14.49	1.3148
	OR	1.0	0.658	0.871	0.835	0.7256
	(95% CI)	(-)	0.319 1.358	0.433 1.753	0.402 1.737	
$\Sigma[a_{wqi}^4 t_i]$ (m^{4}s^{-8}h $\times 10^3$)	median	0.1	0.36	0.99	4.09	2.2472
	OR	1.0	0.579	0.907	0.891	0.5227
	(95% CI)	(-)	0.275 1.219	0.461 1.784	0.447 1.775	

Table 8a. Logistic regression within the transition model of sick leave (> 7 days) due to LBP in the previous 12 months on alternative measures of daily exposure to whole-body vibration (WBV) in the professional drivers (n=230) over one-year follow-up period. Odds ratio (OR) and 95% confidence interval (95% CI) are adjusted for several covariates (Age, physical load factors, psychosocial factors, back trauma, and follow-up time). Each measure of WBV exposure was included as a quartile based design variable, assuming the lowest quartile as the reference category. The likelihood ratio (LR) test for the measures of WBV exposure is given.

Measures of daily WBV exposure		Quartiles of measure of daily WBV exposure				LR test (χ^2, 3*df*)
		Q1	Q2	Q3	Q4	
Daily driving time (h)	median	5.0	8.0	9.4	11.0	5.6488
	OR	1.0	0.626	1.235	2.376	0.1300
	(95% CI)	(-)	0.199 1.971	0.484 3.152	0.866 6.518	
$A_v(8)$ (ms^{-2} r.m.s.)	median	0.28	0.45	0.56	0.74	1.2931
	OR	1.0	0.865	1.371	1.450	0.7308
	(95% CI)	(-)	0.285 2.631	0.509 3.695	0.536 3.920	
$A_{dom}(8)$ (ms^{-2} r.m.s.)	median	0.18	0.32	0.39	0.53	4.4175
	OR	1.0	0.615	1.603	1.688	0.2198
	(95% CI)	(-)	0.203 1.862	0.576 4.463	0.634 4.496	
VDV_v ($ms^{-1.75}$)	median	3.20	4.90	6.46	11.83	4.2801
	OR	1.0	0.713	1.426	2.019	0.2328
	(95% CI)	(-)	0.215 2.366	0.499 4.074	0.762 5.350	
VDV_{dom} ($ms^{-1.75}$)	median	3.26	4.56	5.81	10.34	4.1264
	OR	1.0	0.734	1.569	2.066	0.2481
	(95% CI)	(-)	0.208 2.586	0.571 4.310	0.813 5.249	

Table 8b. Logistic regression within the transition model of sick leave (> 7 days) due to LBP in the previous 12 months on alternative measures of cumulative exposure in most recent job, to whole-body vibration (WBV) in the professional drivers (n=230) over one-year follow-up period. Odds ratio (OR) and 95% confidence interval (95% CI) are adjusted for several covariates (Age, physical load factors, psychosocial factors, back trauma and follow-up time). Each measure of WBV exposure was included as a quartile based design variable, assuming the lowest quartile as the reference category. The likelihood ratio (LR) test for the measures of WBV exposure is given.

Measures of cumulative WBV exposure		Quartiles of measure of cumulative WBV exposure				LR test (χ^2, 3*df*)
		Q1	Q2	Q3	Q4	
Exposure duration (yr)	median	3.2	10.1	21.6	34.8	0.4688
	OR	1.0	0.709	0.771	0.744	0.9257
	(95% CI)	(-)	0.246 2.045	0.277 2.143	0.233 2.375	
$\sum[t_i]$ (h $\times 10^3$)	median	4.6	16.7	34.9	60.7	0.6751
	OR	1.0	1.497	1.208	1.101	0.8790
	(95% CI)	(-)	0.504 4.445	0.380 3.845	0.319 3.796	
$\sum[a_{wsi}t_i]$(ms^{-2}h$\times 10^3$)	median	2.8	7.7	16.4	38.2	2.0108
	OR	1.0	2.037	1.224	1.669	0.5702
	(95% CI)	(-)	0.669 6.200	0.357 4.198	0.491 5.670	
$\sum[a_{wsi}^2t_i]$ (m^{2}s^{-4}h $\times 10^3$)	median	1.1	4.0	8.9	26.9	0.9347
	OR	1.0	1.598	1.447	1.669	0.8170
	(95% CI)	(-)	0.534 4.788	0.480 4.361	0.542 5.144	
$\sum[a_{wsi}^4t_i]$ (m^{4}s^{-8}h $\times 10^3$)	median	0.29	1.2	3.3	14.1	2.6162
	OR	1.0	0.411	0.998	1.015	0.4547
	(95% CI)	(-)	0.123 1.371	0.389 2.564	0.387 2.660	
$\sum[a_{wqi}t_i]$ (ms^{-2}h $\times 10^3$)	median	1.95	5.60	12.16	27.73	3.5167
	OR	1.0	2.240	1.085	2.083	0.3186
	(95% CI)	(-)	0.743 6.751	0.306 3.847	0.633 6.857	
$\sum[a_{wqi}^2t_i]$ (m^{2}s^{-4}h $\times 10^3$)	median	0.59	2.36	4.94	14.49	2.0308
	OR	1.0	1.964	2.105	2.172	0.5660
	(95% CI)	(-)	0.621 6.212	0.672 6.591	0.669 7.056	
$\sum[a_{wqi}^4t_i]$ (m^{4}s^{-8}h $\times 10^3$)	median	0.1	0.36	0.99	4.09	3.5735
	OR	1.0	0.344	1.192	1.070	0.3114
	(95% CI)	(-)	0.091 1.309	0.469 3.027	0.405 2.827	