Risks of Occupational Vibration Exposures

VIBRISKS

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

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SOUTHAMPTON DRIVER LOW BACK PAIN STUDY

ABSTRACT

The possibility that exposure to whole-body vibration may cause disorders of the body has been the subject of many epidemiological studies. Reviews of epidemiological studies of persons occupationally exposed to whole-body vibration conclude that long-term exposure to whole-body vibration is associated with increased risk of low back pain, sciatic pain and degenerative changes in the spinal system.

The cause of low back pain is often uncertain and there are many other possible risk factors that may influence low back pain while driving (prolonged constrained sitting posture without physical activity, back posture during sitting, head posture, back movement, twisting of trunk while looking back, etc). In addition, physical factors (such as lifting, bending, twisting, heavy manual work, etc.), individual factors (such as gender, age, anthropometry, smoking, alcohol consumption, sport, etc.) and psychosocial factors may influence low back pain.

Although car drivers are usually exposed to a lower level of whole-body vibration than drivers of heavy vehicles (e.g. track, tractor, bus drivers, crane operators, etc.), long durations of exposure to vibration experienced by professional car drivers might be associated with low back pain.

The objectives of the research were: (i) to report the prevalence, incidence and recurrence of low back pain in populations of drivers and compare this with populations not exposed to daily driving, (ii) in the populations of car drivers, to identify any occupational factors (related to exposure to whole-body vibration) associated with low back pain, and (iii) to identify other occupational and non-occupational risk factors associated with low back pain in all investigated populations.

The occurrence of low back pain, and risk factors influencing the occurrence of low back pain were investigated in a two-part study of taxi drivers and police employees: a cross-sectional baseline study (based on a single examination of the selected

populations) and a follow-up study (based on a repeated examination of the populations).

Personal information, occupational (present and past) information and health histories of each participant were collected using of self-administered questionnaire.

Measurements of whole-body vibration were performed on a representative sample of vehicles used by taxi drivers and police drivers. The dominant vibration component was the z-axis (i.e. vertical) vibration on the seat from 0.38 to 0.58 ms^{-2} r.m.s. when measured in accord with International Standard 2631 (1997). From the measured vibration and estimated durations of exposure, alternative measures of vibration dose were calculated (daily and cumulative exposure to whole-body vibration).

In the cross-sectional study, the prevalence of low back pain was investigated in 209 taxi drivers from the City of Southampton and in 850 police employees from the Grampian Police Force (365 drivers and 485 non-drivers). From the 209 taxi drivers, the 12-month prevalence of low back pain was 45%, the 4-week prevalence was 29%, and the 7-day prevalence was 11%. From the 365 police drivers, the 12-month prevalence of low back pain was 53%, the 4-week prevalence was 35%, and the 7-day prevalence was 19%. From the 485 non-drivers who responded to the questionnaire, the 12-month prevalence of low back pain was 46%, the 4-week prevalence was 21%, and the 7-day prevalence was 11%.

Multivariate logistic regression in taxi drivers indicated a significant association of low back pain with the following factors: stature, physical load (i.e. repetitive heavy lifting) in previous professions, and increasing level of psychosocial distress. Multivariate logistic regression in police drivers indicated a significant association with the following factors: middle age, performing bending and lifting at work, and increase level of psychosomatic distress. Multivariate logistic regression in non-drivers showed a significant association with the following factors: age, stature, performing bending at work, and increased level of psychosomatic distress.

Multivariate logistic regression in taxi drivers indicated a significant association with increased measures of daily and cumulative exposure to whole-body vibration. In police drivers, multivariate logistic regression did not indicated significantly increased risk of low back with exposure to driving.

In the follow-up study, the incidence and persistence of low back pain was investigated in 144 taxi drivers, 219 police drivers and 300 non-drivers. From 144 taxi drivers, the 12-month incidence of low back pain was 11% and the 4-week, and the 7-day incidence was 3%. From the 219 police drivers, the 12-month incidence of low back pain was 26%, the 4-week incidence was 11%, and the 7-day incidence was 5%. From the 300 non-drivers who responded to the questionnaire, the 12-month incidence of low back pain was 27%, the 4-week incidence was 9%, and the 7-day incidence was 4%. Considering persistent cases of low back pain, from the 144 taxi drivers, 67% reported a persistence of low back pain during the past 12-months and 41% reported a persistent episode during the past 4-weeks, and during the past 7-days. From the 219 police drivers, the 12-month persistence of low back pain was77%, the 4-week persistence was 54%, and the 7-day persistence was 31%. From the 300 non-drivers, 63% reported persistence of low back pain during the past 12-months, 36% reported persistence during the past 4-weeks and 19% during the past 7-days.

Multivariate logistic regression in the investigated groups with persistent low back pain indicated a significant association between low back pain experienced during the past 12-months and the following factors: stature and increasing level of psychosomatic distress in taxi drivers, increasing level of psychosomatic distress status in police drivers, and performing bending at work and middle age in non-drivers.

Multivariate logistic regression in the persistent group of taxi drivers did not suggest that exposure to a longer duration of driving or exposure to whole-body vibration were causes of low back pain. In the population of police drivers, the only significant association was found between increased persistence of low back pain and driving a police vehicle for more than 16 years.

Multivariate logistic regression in the investigated groups with incident low back pain indicated a significant association between low back pain experienced during the past 12-months and the following factors: middle age and increased level of psychosomatic distress in police drivers, and increased level of psychosomatic distress status in non-drivers drivers.

Multivariate logistic regression in the incident group of police drivers suggested that daily exposure to a longer duration of driving or exposure to whole-body vibration were causes of low back pain.

Car driving involves many factors that might influence the risk of low back pain (e.g. duration of driving, exposure to vibration, back posture while driving, lack of movement, forces at the feet when operating foot pedals, load from the arms, head posture, back movement, twisting whole reversing, forces during entry and exit from a car, etc.). The study does not exclude some of these factors increasing the risks of low back pain in some situations. Therefore it is a complex task to investigate if car driving is causing low back pain.

The population of car drivers and the population of non-car drivers include a large number of people with low back pain. It is therefore appropriate to seek a better understanding of the risk factors for low back pain in both car drivers and non car drivers.

1. INTRODUCTION

The possibility that exposure to whole-body vibration may cause disorders of the body has been the subject of many epidemiological studies. From reviews of studies of people exposed to occupational whole-body vibration it seems that one of their most common health problems is low back pain, followed by sciatic pain, and degenerative changes in the spinal system (Damkot *et al*., 1984; Magora, 1974; Svensson *et al*., 1983; Svensson *et al*.,1989)

Low back pain is a very common disease in developed countries and affects almost all individuals at some time. Overall, about 16.5 million people from Great Britain suffer from back pain in any year (Chambers *et al*., 2001). In a typical 1-year period, approximately five million people consult their GP about back pain. The cost of primary care provided by GPs related to back pain in 1998 has been estimated at £140.6 million. The total annual estimated cost associated with care (general practice, private consultants, physiotherapists, etc.) and treatment (prescriptions, over the counter medication, etc.) of back pain in 1998 has been estimated at £1632 million (Maniadakis and Gray, 2000).

Many epidemiological studies and several reviews of epidemiological studies of persons exposed to whole-body vibration (especially tractor drivers, truck drivers, bus drivers, helicopter pilots and drivers of heavy off-road machines) have concluded that long-term exposure to whole-body vibration is associated with increased risk of health problems (low back pain, digestive and reproductive system disorders, peripheral nervous system disorders and vestibular and visual system problems) (Bongers *et al*., 1988; Boshuizen *et al*., 1990; Boshuizen *et al*., 1994; Bovenzi and Betta, 1994; Bovenzi, 1996; Dupuis and Zerlett, 1997; Griffin, 1982; Seidel and Heide, 1986; Bovenzi and Hulshof, 1999)

The cause of low back pain in workers exposed to whole-body vibration is often uncertain. In addition to vibration, there are many other risk factors that may influence low back pain while driving (prolonged constrained sitting posture without physical activity, back posture during sitting, head posture, back movement, twisting of trunk while looking back, etc). In addition, physical factors (such as lifting, bending, twisting, heavy manual work, etc.), individual factors (such as gender, age, anthropometry, smoking, alcohol consumption, sport, etc.) and psychosocial factors may influence low back pain.

As previously stated, there have been studies investigating low back pain among many different professional drivers. However, the studies mostly considered low back pain among drivers of trucks, tractors, busses and heavy machines. Car drivers are exposed to a lower level of whole-body vibration than drivers of tractors, trucks, buses, helicopters and off-road machines, but have some of the other risk factors (i.e. individual factors, physical factors and psychosocial factors). Some epidemiological studies have investigated the prevalence of low back pain in professional car drivers, but these studies may be considered unsatisfactory due to the lack of information about driving (duration of driving, whole-body vibration exposure, etc.).

This report summarises of a cross-sectional and longitudinal study of low back pain among a population of car drivers (taxi drivers and police drivers). The objectives of the research were: (i) to report the prevalence, incidence and recurrence of low back pain in the populations of drivers and compare this information with populations not exposed to daily driving (i.e. police non-drivers), (ii) in the populations of car drivers to identify any occupational factors (related to exposure to whole-body vibration) associated with low back pain, and (iii) to identify other occupational and non-occupational risk factors associated with low back pain in all investigated populations.

2. METHODS

2.1. Study population

2.1.1. Taxi drivers

The target population was 861 taxi drivers located in the City of Southampton. Information on the number and contact details of the taxi drivers operating in the City of Southampton was provided by the Legal and Democratic Services of Southampton City Council. The range of age drivers was from 27 to 78 years.

The majority of the taxi drivers in the survey were self-employed and worked full-time. Full-time drivers usually worked 8 to 12 hours per day. Part-time drivers worked fewer hours per day or worked 8 to 12 hours once or twice a week. Working hours could change from day to day depending on season, weekends and holidays.

2.1.2. Police employees

The target population was 2105 persons employed by the Grampian Police. Information on the number and contact details were provided by the Service Centre of Aberdeen Police Station.

Most of the police employees used cars. However, some individuals had no use, or little use, of motor vehicles. Therefore police employees could be divided into following groups:

Drivers

- Squad drivers who drove general purpose patrol vehicles (e.g. Vauxhall Astra, Ford Focus) or unmarked vehicles.
- Drivers of high-speed traffic vehicles (e.g. Vauxhall Omega, Volvo, Range Rover)

Non-drivers

Sitters

- Employees of the force control centre. The job involved 8-hours sitting shifts while operators looked at computer screens, using a mouse, keyboard and radio. Operators could move around when they needed but they sat for about 95% of the working time
- Employees of the Service Centre who performed a similar job as operators of the Force Control Centre
- Supporting staff who spent much of the working time sitting
- Others. Various police jobs and practices resulting in little use of cars and more sitting

Walkers

- Traffic wardens who were provided with a police car but spent most of their working time walking
- Community workers who spent most of the time walking but used private cars for occasional journeys
- Community police officers working in the town and walking for the entire shift
- Others. Various police jobs and practices resulting in little use of cars and more of the time walking

2.2. Type of study

The survey had a longitudinal design (also called cohort design). The prospective cohort study had a cross-sectional assessment at baseline with a follow-up after one year.

2.1.2. First step – Baseline cross-sectional study

The initial results from the first monitoring (baseline) reflect a single examination of the relationship between health outcomes and investigated risk factors (i.e. the dependent and the independent variables). The investigated variables measured the prevalence of health outcomes or determinants of health, or both. To accept a risk factor as being important for low back pain, it has been suggested that the association between the risk factor and low back pain should be strong, the association should be repeatedly observed, and the underlying causes of the relationship should be as specific as possible (Rey, 1979). The factors identified as statistically significant in a cross-sectional study cannot be assumed to be predictive of low back pain, but a cross-sectional study can help to identify the risk factors to be considered in a follow-up epidemiological study. The results from the first monitoring of the relationship between low back pain outcomes and risk factors possibly causing these health problems will be examined and reported as an independent part of the study and is called the baseline cross-sectional study.

2.1.2. Second step - Longitudinal study

The follow-up examination of the populations took place 12 months later after the initial monitoring. The design of the longitudinal study allowed the estimation of incidence and persistence rate and the relationship between risk factors and health problems.

2.3. Data collection - Questionnaire

Information on risk factors and health outcomes was collected on two ocations (at baseline and follow-up) using a self-completed postal questionnaire. The questionnaire was based on the VIBRISKS whole-body vibration questionnaire for longitudinal epidemiological studies. The questionnaire was enriched by a set of health questions selected from existing models used in earlier MRC community surveys in the UK. These questions permit an assessment of the severity and frequency of symptoms. The final version of the questionnaire was consistent with the VIBRISKS questionnaire. The similar structure to the questionnaires will enable comparisons with data collected by other VIBRISKS partners.

2.3.1. Structure of the questionnaire

<u>Baseline questionnaire</u>

The questionnaire included a maximum of 70 questions which were structured and had mainly binary or multiple choice answers. The questionnaire required up to 30 minutes to be completed. The questionnaire was divided into five main parts:

- The first section included questions about personal and general characteristics and the driver's personality, such as age, height, weight, smoking habits, sport and activity. For further analysis, information such as age, height and weight were classified in three bands (approximate thirds). Information about smoking and practising of sport were treated as dichotomous variable (YES/NO).

- The second section focused on information about the current job such as working activities (i.e. lifting, digging, working posture, standing or walking, sitting, etc.). Work activities were assessed by using of frequency or duration of the working task per one working day For further analysis the working activities were classified as dichotomous variables (lifting: not at all (NO), 1-10 times and more than 10 times per day (YES); bending, twisting (YES/NO); walking or standing: none and less than one hour (NO), 1-3 hours and more than 3 hours per day (YES); sitting other than when driving: less than an hour and 1-3 hours (NO), more than 3 hours per day (YES).

  The section about occupational history provided information about the vehicle being driven (i.e. vehicle type, time spend driving per one working week, experience of discomfort and mechanical vibration or shock). Information about the duration of driving exposure and vibration measurement performed on selected type of vehicles were used for calculation of different metrics of whole-body vibration exposure.

  The last part of the second section was concerned about psychosocial risk factors at work. The questions were based on the Karasek model where the work-related psychosocial risk factors are measured on a 4-point scale. For further analysis, subjects were classified into two groups according to their responses (job decision and job support: often and sometimes (YES), seldom and never/almost never (NO); job satisfaction: very satisfied and satisfied (YES), dissatisfied and very dissatisfied (NO)) In the case of taxi drivers, the answer 'not applicable' was added in the question about support decision because taxi drivers are often self-employed and work alone).

- The third section focused on other jobs participants may have held in the past. Information was focused on the type of vehicle driven in the past, previous sitting, and previous heavy physical demands (e.g. frequent heavy lifting) at work. All information was treated as dichotomous variables (previous driving (YES/NO); previous prolonged sitting: no previous job, no sitting and sitting less than an hour per day (NO), sitting for more 1-3 hours and more than 3 hours per day (YES)).

- The fourth part of the questionnaire was based on the Nordic questionnaire (Kuorinka *et al.*, 1987) and concerned aches and pains which may have occurred in different parts of the body (pain in the low back, pain in the neck, pain in the shoulders) and at different times (during the past 12 months, 4 weeks or last 7 days).

  Low back pain was defined as pain in the area shown in the diagram (see Figure 1), which lasted more than one day during the past 12 months, 4 weeks or 7 days. All participants experiencing low back pain during the past 12 months replied also to additional questions about low back pain symptoms. Additional information was provided on the duration of low back pain episodes, days off due to episodes of low back pain, visits to a doctor due to low back pain, presence of sciatica, disability due to episodes of low back pain (using the Roland and Morris disability scale – 24 questions concerning the impact of low back pain on daily activities such as walking, working, dressing up, standing, sitting, etc.), rating of pain intensity of last low back pain episode on 0-10 point scale proposed by Von Korff *et al.,* 1992, etc.

- The last section explored the feelings about health symptoms. The section contained information about low mood of participants (based on the SF-36 questionnaire short form of questionnaire measuring health status). Five of

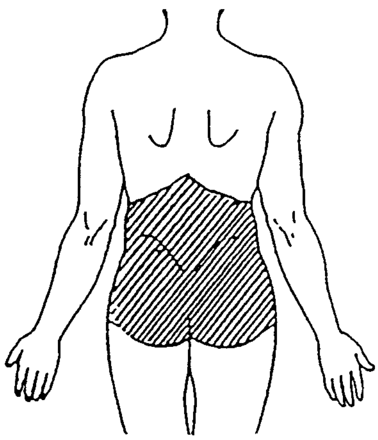

Figure 1 Definition of low back pain in self-administered questionnaire

these questions were designed to assess the mental health of the respondent and four of these questions were used to assess energy and vitality. Answers to these questions were scored and added together for all five questions about mental health and all four questions about energy and vitality. Scores were then divided into three subgroups characterising the health status of the respondent (approximate thirds based on the distribution of scores). Participants with a high score on questions regarding mental health were identified as mentally healthy, drivers with a lower score were grouped as medium mentally healthy, and drivers who had a low score were identified as having a poor mental health. The same procedure was carried out with the total score from responses on energy and vitality questions, giving three subgroups: energy and vitality healthy respondents, energy and vitality medium, and energy and vitality poor respondents. Question detecting the level of psychosomatic distress of the drivers consisted of 10 sub-questions about how different problems distressed or bothered the respondent. After the summation of the scores, three subgroups (approximate thirds based on the distribution of scores) were formed characterising the different stages of psychosocial distress among participants. The first group was formed from participants who were not distressed or bothered by any of the possible problems. The remaining drivers were then equally distributed into the second and third group. The second group contained participants with a 'medium distress status', and third group contained participants who reported a 'high distress status'.

The questionnaires for the two selected populations differed in the part about professional driving, where each population chose from different options characterising the vehicles driven in the job.

Follow-up questionnaire

The follow-up questionnaires were distributed 12 months or later after the initial questionnaire. In the follow-up, all participants who had replied in the first year of the study were followed.

The follow-up questionnaire was based on the structure of the questionnaire used in the baseline. Questions from the initial questionnaire were excluded if they would not bring new information about the participant (such as some anthropometric information, leisure activities, information about previous jobs, etc.) and some irrelevant questions (such as information about direction of vibration).

The follow-up questionnaire consisted of 48 questions and was also divided into five main parts as explained above. The questionnaire required up to 20 minutes to be completed.

Examples of baseline and follow-up questionnaires are provided in Appendix A.

2.3.2. Distribution of the questionnaire

A questionnaire with accompanying letters and a pre-paid sealed envelope was sent (by mail to the population of taxi drivers and by internal post to the population of police employees) to each participant on two occasions (baseline and follow-up).

Each questionnaire package contained two accompanying letters. One of the accompanying letters was from the researchers and the other from the Legal and Democratic Services (in the case of the taxi driver population) or from the Chief Superintendent of the Grampian Police Force (in the case of police employees). The accompanying letters were designed to enhance the motivation to answer the questionnaire and briefly explained the purpose of the study.

To enhance the response rate of participants a financial bonus was proposed. In the case of taxi drivers, a small cash reward was offered to five randomly selected drivers who answered both questionnaires (baseline and follow-up). In the case of police employees a small financial amount was donated to the Diced Cap Charitable Trust for each completed questionnaire.

The questionnaire package did not identify the name or address of the participant but a reference number identified them. The coding system, which was based on matching the reference number to the names and addresses of subjects (created and printed by the Licensing officer from the Southampton City Council and by the Service Centre of Aberdeen Police Station), was securely stored for our use in the event of loosing of the original coding.

The follow-up study needed a high response rate from participants who had replied in the baseline. Therefore three reminder rounds, where each participant received a new copy of the questionnaire and reminder letters, were sent in the case of the taxi drivers and one reminder was performed in the case of police employees.

2.4. Data collection - Driving exposure

The driving exposure in the present occupation was calculated for each participant using of information from the questionnaire and whole-body vibration measurements.

2.4.1. Information from the questionnaire

Information on vibration exposure was obtained from work histories.

The driving exposure in the present occupation (expressed as duration in hours) was calculated by multiplying the mean number of driving hours per week by the number of working weeks per year (one working year = 40 working weeks) multiplied by the number of years in the job.

2.4.2. Measurement of vibration exposure

Exposure to whole-body vibration was measured on a sample of vehicles (3 taxis, and 7 police vehicles) in accord with International Standard 2631 (1997).

Measurement equipment

Acceleration in selected vehicles was measured using piezoresistive accelerometers (Entran EGCS-DO-10 and Entran EGCSY-240D-10). Fore-and-aft acceleration (*x*-axis), lateral acceleration (*y*-axis) and vertical acceleration (*z*-axis) was measured on the driver's seat pan using three accelerometers in a SIT-pad. A SIT-pad containing one accelerometer was used to measure fore-and-aft vibration between the backrest and the driver. The vertical floor vibration was measured by an accelerometer secured to the front seat rail of the driver's seat.

The signals from the five accelerometers were acquired to a portable digital computer-based data acquisition and analysing system, *HVLab* (version 3.81). The computer system was connected to 12-volt rechargeable battery in the cabin of the vehicle. The acceleration was low-pass filtered at 80 Hz and then digitized at 200 samples per second. The equipment used for the measurements is shown in Figures 2 and 3.

The same journey was used to test all vehicles: the vehicles were driven over surfaces appropriate to normal daily driving. The measurement of vibration commenced at a predetermined location and lasted for 20 minutes.

Estimation of real duration of exposure to whole-body vibration in taxi drivers

Cumulative exposure to whole-body vibration was recorded in six taxi vehicles using a similar measurement set-up as used for the 20-minute measurements. Five accelerometers (the position of accelerometers is defined in the previous paragraph) continuously acquired data to a computer-based data acquisition and analysing system (in Matlab) during the entire driving shift which lasted up to 8 hours. The acceleration waveforms were low-pass filtered at 80 Hz and then digitized at 400

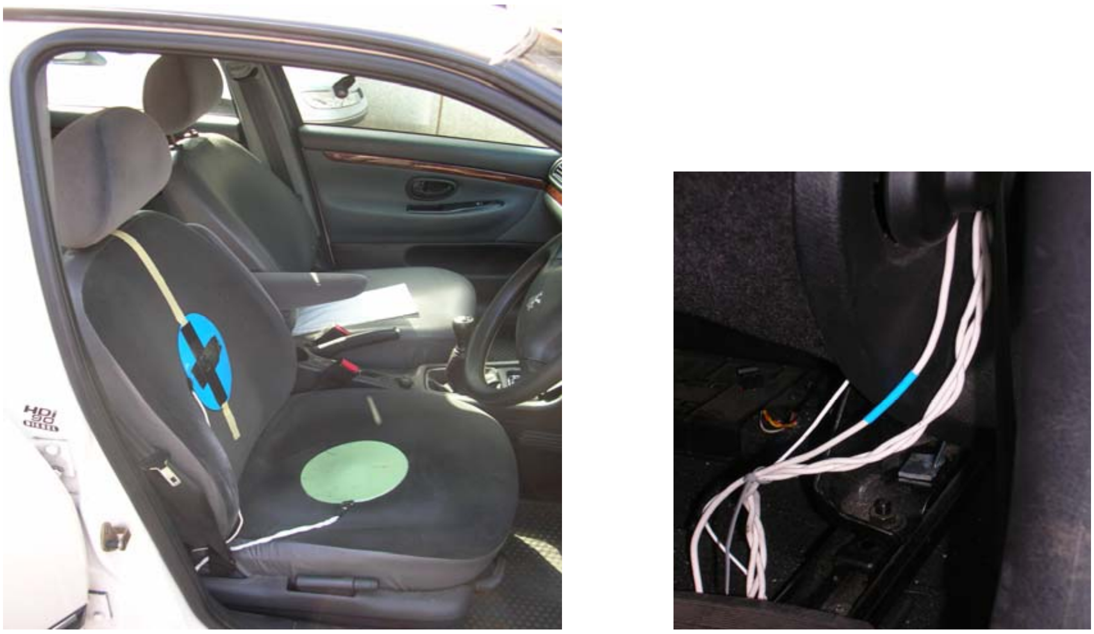

Figure 2. Measurement system (placement of SIT pad on the driver's seat)

samples per second. The computer system was connected to a 12-volt rechargeable battery placed in the boot of the vehicle; all wires connecting accelerometers and battery were attached to the vehicle floor to eliminate the possibility of interfering with the driver or passengers. For the equipment used in the measurements see Figure 4.

All drivers were asked to drive the vehicle as usual during their working shift and returned after 8 hours of work so that the measurement system could be removed from the vehicle.

The measured data were transferred to the data acquisition and analysing system, *HVLab* (version 3.81). From the data-set were extracted time segments when the engine of the vehicle was shut down.

After the measurement, drivers were asked to complete a simple questionnaire asking about the characteristics of the ride, including the duration. Information about the duration of driving was then compared with the durations the engine of the vehicle was running and the vehicle was moving (obtained from the measured vibration data) to quantify the accurancy of the driver's estimate of his driving duration

Figure 3. Measurement system (portable digital computer-based data acquisition and analysing system, *HVLab* (version 3.81) and 12-volt rechargeable battery

2.5. Analysis of results

2.5.1. Frequency weightings

The acceleration was frequency-weighted using frequency weightings defined International Standard 2631 (1997). As stated in the standard, different frequency weightings and multiplying factors are required for the different axes of vibration and for the different effects of vibration on the body. In International Standard 2631, the frequency weightings required for the evaluation of the effect of whole-body vibration exposure on health are W_d and W_k. Frequency weightings and multiplying factors recommended for the evaluation of whole-body vibration with respect to health are shown in Table1.

2.5.2. Calculation of dose measures for whole-body vibration proposed by VIBRISKS (working document WP4-N14)

Averaging methods: r.m.s and r.m.q.

The r.m.s value was calculated using true integration:

$$a_{\text{r.m.s.}} = \left[\frac{1}{T} \int_{t=0}^{t=T} a^2(t)\,dt \right]^{1/2}$$

The r.m.q. value should also be calculated using true integration:

$$a_{r.m.q..} = \left[\frac{1}{T} \int_{t=0}^{t=T} a^4(t)dt \right]^{1/4}$$

where *a(t)* is the frequency-weighted acceleration and *T* is period (in seconds) during which the vibration was measured.

Calculation of doses

For the calculation of the dose using r.m.s. measures, the root-sums-of-squares of the r.m.s. values was used to obtain the weighted acceleration a_{ws}:

$$a_{ws}=(1.4a^2_{x,w}+1.4\ a^2_{y,s}+\ a^2_{zs})^{1/2}$$

Measurements in the x-axis on the backrest of the seat were not included in the calculations.

For the calculation of the dose using r.m.q. measures, the root-sums-of-quads of the r.m.q. values was used to obtain the weighted acceleration a_{wq}.:

$$a_{wq}=(1.4a^4_{x,w}+1.4\ a^4_{y,s}+\ a^4_{zs})^{1/2}$$

Table 2 summarises the dose measurements that were calculated for each individual using the individual exposure durations and measurements of vehicle vibration. The

Table 1. Frequency weightings and multiplying factors as specified in International Standard 2631 (1997)

Location of the measurement	Weighting ISO (2631)	Multiplying factor ISO (2631)
Seat		
fore-anf-aft acceleration (x-axis)	W_d	1.4
lateral acceleration vertical acceleration (y-axis)	W_d	1.4
vertical accelertion (*z*-axis)	W_k	1

Figure 4. Measurement system (portable digital computer-based data acquisition and analysing system, *Matlab* and 12-volt rechargeable battery

table summaries the calculation of whole-body vibration dose as proposed by VIBRISKS (working document WP4-N14).

2.5.3. Calculation of daily and total life-time (cumulative) exposure to whole-body vibration in drivers

For each driver participating in the study, the estimated daily ($eVDV_{dom}$) and estimated total life-time vibration dose values ($eVDV_{Total\text{-}dom}$) were calculated in accord with International Standard 2631 (1997) from knowledge of the type of driven vehicle, the dominant frequency-weighted r.m.s. acceleration measured in the vehicle, and the hours of driving during the average working week and the number of years of driving as reported by each drivers in the questionnaire (for this calculation it was assumed that there were 40 weeks in the year).

The vibration dose value for each axis of measured whole-body vibration was calculated as follows:

$$eVDV = 1.4\, a_t\, t^{1/4} \quad (ms^{-1.75})$$

Table 2. Dose measures proposed by VIBRISKS WP4-N14

DOSE	FORMULA	DESCRIPTION	UNITS
Dose 1	$T = \Sigma t_{Ti}$	Total hours of exposure	hours
Dose 2	$\Sigma a_{wsi}.t_i$	r.m.s. at total dose	$m s^2.h$
Dose 3	$\Sigma a_{wsi}^2 t_i$	r.m.s. a^2t total dose	$m^2 s^4.h$
Dose 4	$\Sigma a_{wsi}^4 t_i$	r.m.s. a^4t total dose	$m^4 s^8.h$
Dose 5	$\Sigma a_{wqi}.t_i$	r.m.s. at total dose	$m s^2.h$
Dose 6	$\Sigma a_{wqi}^2 t_i$	r.m.s. a^2t total dose	$m^2 s^4.h$
Dose 7	$\Sigma a_{wqi}^4 t_i$	r.m.s. a^4t total dose	$m^4 s^8.h$
Dose 8	$\lvert[(\Sigma a_{wsi}^2 t_i)/ (\Sigma t_i)]^{½}\rvert_{max}$	Max r.m.s. any machine	$m s^2$
Dose 9	$\lvert[(\Sigma a_{wqi}^4 t_i)/ (\Sigma t_i)]^{¼}\rvert_{max}$	Max r.m.q. any machine	$m s^2$
Dose 10	$Y = \lvert D2 - D1\rvert_{max}$	Total years exposure	years
Dose 11	$\lvert t_{d(n)}\rvert_{max}$	Max daily exposure each machine	hours
Dose 12	$A(8) = \lvert(\Sigma a_{wsi}^2.t_{di}/ T_{(8)})^{½}\rvert_{max}$	Max r.m.s. A(8) each machine	$m s^2$
Dose 13	$VDV = \lvert a_{wqi}.(t_{di}.60.60)^{¼}\rvert_{max}$	Maximum daily VDV any machine	$m s^{1.75}$
Dose 14	$A(8) = (\Sigma a_{wsi}^2.t_{di}/ T_{(8)})^{½}$	Current r.m.s. A(8)	$m s^2$
Dose 15	$VDV = \lvert a_{wqi}.(t_{di}.60.60)^{¼}\rvert_{current}$	Current daily VDV	$m s^{1.75}$
Past exposure	*Hours of exposure to WBV in previous jobs*	Hours of exposure to WBV in previous jobs	hours
Leisure exposure	*Hours of exposure to WBV in leisure*	Hours of exposure to WBV in leisure	hours

where *a(t)* is the frequency-weighted acceleration and *T* is the period (in seconds) during which the vibration was measured.

2.5.2. Statistical analysis of questionnaire information

All participant questionnaire responses were independently double-entered to computer. A cross-comparison test was used to identify errors, inconsistencies and improbable and impossible values in both data entries. Further analysis of taxi drivers was carried out using SPSS 13.0 for Windows.

The differences between continuous data of different populations were investigated by one-way between groups ANOVA (parametric statistic) or Kruskal-Wallis test (non-parametric statistic). The differences between categorical data of different populations were investigated by Chi-square statistic.

For further analysis, continuous information such as age, height, weight, driving information (durations, WBV metrics) was classified as categorical variables in three bands (approximate thirds).

Association of whole-body vibration, professional driving and other possible influencing factors (individual risk factors, physical risk factors at work and psychosocial risk factors) with low back pain was examined using logistic regression, expressed as Odds Ratio (OR) and 95% Confidence Interval (95% CI). Logistic regression was used to look at the association between the dependent variable (low back pain) and independent variables with possibility also controlling for the effects of other independent variables.

In the first step of the cross-sectional baseline of the longitudinal study, each potential risk factor for LBP (experienced on at least one day during the past 12 months) was examined using univariate logistic regression. All variables, for which the univariate test had a *p*-value less than 0.5 and age since it is a variable of known biologic importance, were considered for the subsequent multivariate logistic regression analysis. In the second step, a multivariate logistic regression analysis was performed.

In the second step, was performed a multivariate logistic regression. The first type of multivariate analysis was a standard multiple logistic regression (regression is based on entering all significant variables for low back pain outcomes into a logistic model to examine the contribution of all possible variables at the same time). Separate multivariate models were used for each measure of WBV exposure. The final cross-sectional analysis of the baseline of the longitudinal study was a stepwise logistic regression. In the stepwise method, the variables with highest statistical significance were added the model one at time. Stepwise logistic regression was used to select possible risk factors (the factors remaining significantly associated with the prevalence of LBP in the stepwise regression model) to be investigated as risk factors predictive of LBP in the follow-up of the longitudinal study.

In the follow-up of the longitudinal study, all risk factors selected by stepwise logistic regression in the baseline and age were entered into a final statistical model. For each value of WBV exposure, final statistical models were formed for the ‘incidence group’ (participants without symptoms of LBP in the baseline of the study but with symptoms of LBP in the follow-up) and the ‘persistence group’ (participants reporting LBP symptoms in the baseline of the study and also reporting LBP in the follow-up) so as to investigate associations between risk factors and LBP experienced on at least one day during the past 12 months.

3. RESULTS

3.1. Cross-sectional baseline of longitudinal study

3.1.1. Description of the population

Taxi drivers

From the total of 861 posted questionnaires, 222 responses were returned, giving an overall response rate of 26%. One hundred and thirty one responses were obtained at the first round and a further 91 responses were obtained after the reminder. From the total of 222 responses, thirteen cases were excluded because they did not wish to participate in the study or they were no longer taxi drivers. In total, 209 questionnaires were used from the total of 861 taxi drivers, representing a response rate of 24%.

The average age of the drivers was 50 years with an age range from 23 to 78 years. All individual information about the taxi drivers is listed in Appendix B (Table B1).

The physical activities performed in the job, which are called physical factors at work, and information about driving details such as the duration as a professional taxi driver, type of vehicle driven, duration of driving, off-road driving, and unloading of vehicles are listed in Table B2.

Psychosocial risk factors derived from the questionnaires are listed in Table B3.

The age, anthropometric information (height, weight), mental health, energy and vitality status and psychosocial distress were divided into subgroups of participants as used in statistical analysis. The cut points for the division into subgroups were created to allow the distribution of subjects into approximate thirds.

Police employees

From the total of 2105 posted questionnaires, 852 responses were returned, giving an overall response rate of 41%. From the total of 852 responses, 850 questionnaires were used and two cases were excluded because they did not wish to participate in the study.

The average age of employees was 40 years with an age range from 19 to 77 years.

The police employees who reported driving for more than 5 hours per week during their working shift were marked as drivers and the rest of the employees were marked as non-drivers. From the total of 850 police employees, who participated in the study, 365 have been classified as police drivers and 485 have been classified as non-drivers. The descriptive characteristics of the driving population and non-driving population (individual characteristics, physical activities, psychosocial status and driving information) are shown in Table B1–B3.

Drivers

Similarities in the information from police drivers and taxi drives allowed the pooling of the data into a group of drivers. The descriptive characteristics of the driving population (individual characteristics, physical activities, psychosocial status and driving information) are shown in Table B1–B3.

The main differences in key information (age, height, weight, years of work, and hours of work) are summarised in Table B4.

3.1.2. Prevalence of low back pain and other health outcomes

Taxi drivers

Of the 209 drivers who responded to the questionnaire, 94 (45%) had experienced low back pain during the past 12 months that lasted more than one day, 61 (29%) had experienced low back pain during the past 4 weeks, and 22 (11%) had experienced low back pain during the past 7 days (Figure 5).

Police drivers

Of the 365 police drivers, 195 (53%) had experienced low back pain during the past 12 months that lasted more than one day, 129 (35%) had experienced low back pain

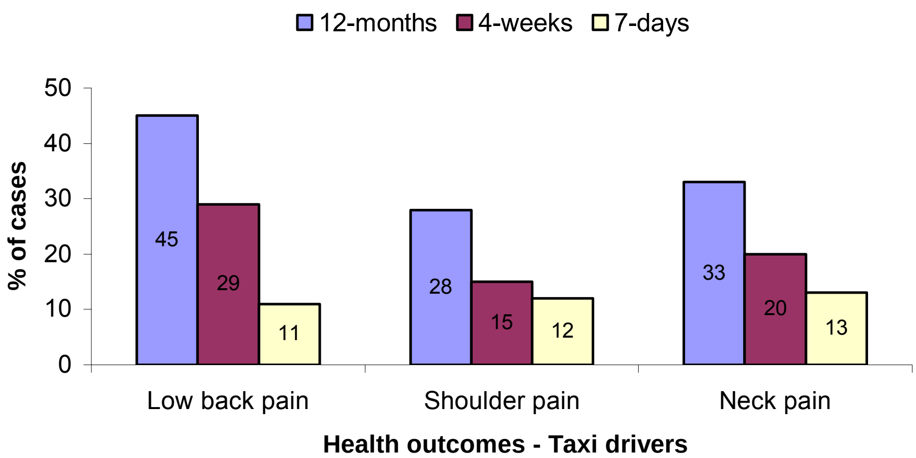

Figure 5. Prevalence of low back pain, shoulder pain and neck pain among taxi drivers (cross-sectional study)

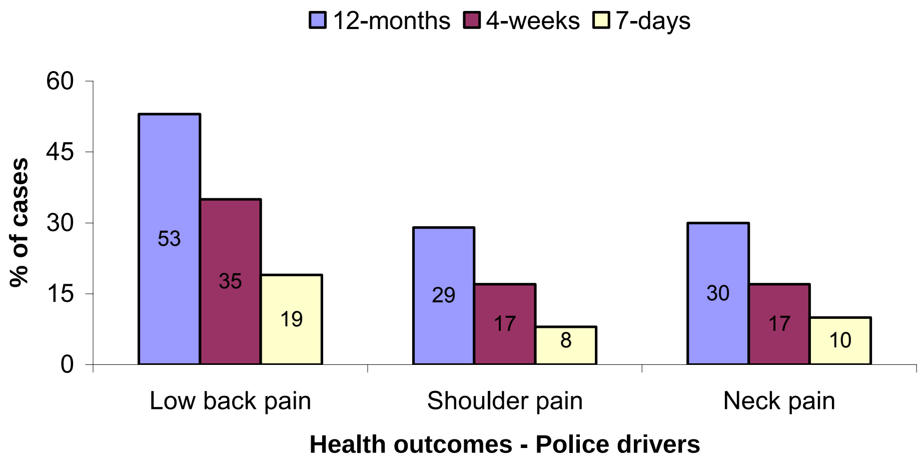

Figure 6. Prevalence of low back pain, shoulder pain and neck pain among police drivers (cross-sectional study)

during the past 4 weeks, and 70 (19%) had experienced low back pain during the past 7 days (Figure 6).

Police non-drivers

Of the 485 police non-drivers, 221 (46%) had experienced low back pain during the past 12 months that lasted more than one day, 100 (21%) had experienced low back pain during the past 4 weeks, and 54 (11%) had experienced low back pain during the past 7 days (Figure 7).

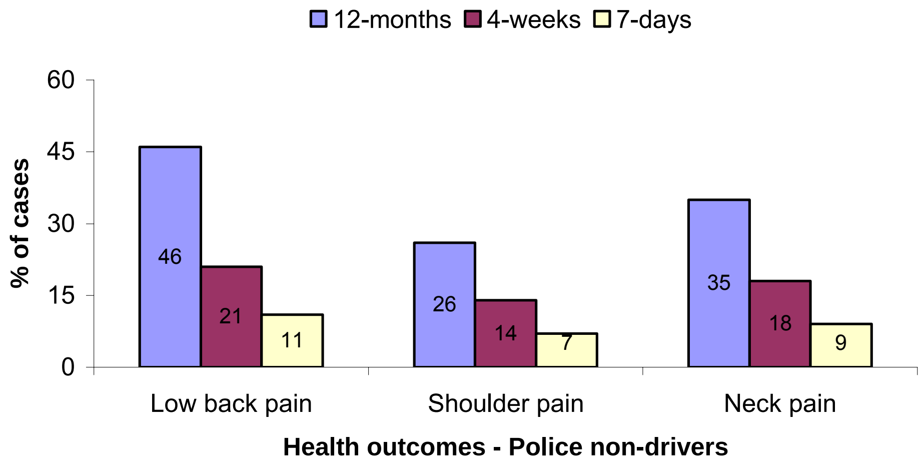

Figure 7. Prevalence of low back pain, shoulder pain and neck pain among police non-drivers (cross-sectional study)

Drivers

Of the total of 574 drivers (taxi drivers and police drivers) who responded to the questionnaire, 289 (50%) had experienced low back pain during the past 12 months that lasted more than one day, 190 (33%) had experienced low back pain during the past 4 weeks, and 109 (19%) had experienced low back pain during the past 7 days (Figure 8).

Taxi drivers, police drivers and police non-drivers also reported other health outcomes, such as shoulders pain and neck pain. The prevalence rates of other health outcomes together with the prevalence rates of low back pain are illustrated in Figure 5-8.

Detailed information on the occurrence of LBP symptoms and other health outcomes is provided in Table B5a and B5b.

3.1.3. Risk factors for low back pain

Univariate analysis (Simple logistic regression)

Possible risk factors for low back pain derived from the questionnaires were divided into four subgroups: individual risk factors, physical risk factors, psychosocial risk factors, and driving factors.

Each possible risk factor was entered into a simple logistic regression to evaluate the possible relationship to low back pain outcome.

Individual factors

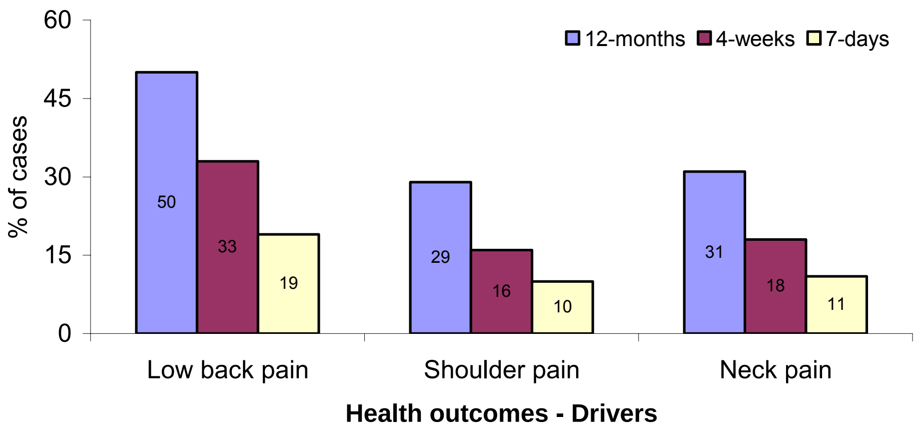

Figure 8. Prevalence of low back pain, shoulder pain and neck pain among pooled population of drivers (cross-sectional study)

From the individual factors, an increased prevalence of low back pain during the past 12 months was found in all age group compared to group of youngest participants. Statistically significant associations were found in oldest group of police non-drivers (odds ratio, OR = 1.86) and middle age group of police drivers (OR = 2) and pooled group of all drivers (OR = 1.57). Gender, to be exact being a male, showed a significant relationship with low back pain in the population of non-drivers (OR = 1.86). Stature showed a significant relationship with low back pain in taxi drivers (medium height, OR = 3.09), the pooled group of drivers (middle stature: OR = 1.75; high stature: OR = 2.43) and in the police non-drivers where the risk was more than double in tall people (OR = 2.43) than in short people. Increasing weight also seemed to be associated with increased risk of low back pain in all populations. There was a significantly increased risk of low back pain mainly in the heavy group of participants (in almost all populations the risk of having low back pain during the past 12 months was double that in light participants (taxi drivers: OR = 2.6; police drivers: OR = 2.54; pooled group of all drivers: OR = 2.33; non-drivers: OR = 1.98). Smoking, or previous smoking, was associated with increased prevalence of low back pain in taxi drivers (OR = 1.73). However, the association between smoking and low back pain was not statistically significant.

Physical factors

A longer duration of work (expressed in hours worked per week) was associated with increased prevalence of low back pain in all populations. However, a statistically significant relationship with low back pain was found only with working for more than 40 hours per week in the population of non-drivers (OR = 1.62). From other physical work factors, low back pain during the past 12 months was significantly associated with lifting (taxi drivers: OR = 2.84; police drivers: OR = 1.84; pooled group of drivers: OR = 1.74), lifting while bending (taxi drivers: OR = 2.35; police drivers: OR = 2.06; pooled group of drivers: OR = 1.77), lifting while twisting (taxi drivers: OR = 1.82; police drivers: OR = 2.03; pooled group of drivers: OR = 1.64), and lifting while bending and twisting (taxi drivers: OR = 1.97; police drivers: OR = 2.39; pooled group of drivers: OR = 1.83) in all driving populations. Awkward posture, such as bending, was significantly related to low back pain in police drivers (OR = 2.08), non-drivers (OR = 1.7), and in the pooled group of drivers (OR = 1.73) where there was also a significant association with twisting (OR = 1.57). When considering previous professions, low back pain was significantly associated with previous jobs requiring heavy physical demands, such as heavy and repetitive lifting in taxi drivers (OR = 2.1) and in the pooled group of drivers (OR = 1.44).

Psychosocial factors

There were no clear associations between low back pain during past 12 months and psychosocial factors at work. A significant association with low back pain was found only with low satisfaction (OR = 2.19) and low support from colleagues (OR = 2.17) in the police drivers and with a low satisfaction at work in the pooled group of drivers (OR = 1.75). Psychosomatic distress seemed to be a significant predictor of low back pain in all investigated populations. In population of taxi drivers the risk of low back pain in the highly distressed group was more than seven times greater than in the group with no distress (OR = 7.77).

The individual associations between the selected risk factors and low back pain experienced for at least one day during past 12-months in all populations are presented as odds ratios with 95% confidence interval and showing the significance of the associations in Tables B6a and 6b.

Driving information

The differences in duration of driving and vibration exposure between the drivers groups are presented in Table B7a and B7b. The information on the present duration of exposure (in hours per week), hours driven in total in the present profession (total duration is calculated by using of 40 weeks in one working year. Vibration exposure is presented in the form of an 8-hour energy-equivalent frequency-weighted acceleration magnitude $A(8)$ (calculated using of the root-sums-of-squares of the r.m.s. values measured in the vehicle and also by using acceleration only in the dominant axis of vibration), daily vibration dose value (calculated using both acceleration in the dominant axis of vibration and a total vibration dose value calculated using the root-sums-of-squares of the r.m.s. values) and estimated total lifetime vibration dose value (calculated using acceleration in the dominant axis of vibration).

In the populations of taxi drivers, univariate tests showed an increasing prevalence of low back pain in groups reporting increased daily exposure to whole-body vibration. A significant association was found in the driving groups reporting highest daily exposure to whole-body vibration (i.e. daily driving time expressed in hours: OR = 2.1; $A_{sum}(8)$: OR = 2.55; $A_{dom}(8)$: OR = 2.68 and $eVDV_{dom}$: OR = 2.3). In the population of police drivers and pooled group of drivers was not found any significant association between increased prevalence of low back pain experienced for at least one day during the past 12-months and any metrics of daily exposure to whole-body vibration.

There was found a trend of increasing prevalence of low back pain with increasing cumulative exposure to whole-body vibration in taxi drivers and police drivers. In taxi drivers, significant association was found in groups reporting highest cumulative exposure to whole-body vibration in the form of total life-time eVDV (OR = 1.98) and $\sum[a_{wqi}{}^4 t_i]$ (OR = 2.05). In the pooled group of all drivers was found significant association between increased prevalence of low back pain and driving for more than 16 years (OR = 1.71) and highest cumulative exposure to whole-body vibration in the form of $\sum[a_{wsi}{}^4 t_i]$ (OR = 1.54).

The individual associations between the daily and cumulative exposure to whole-body vibration and low back pain experienced for at least one day during past 12-months in all populations are presented as odds ratios with 95% confidence interval showing the significance of the associations in Tables B8a and B8b.

Multivariate analysis (Multiple logistic regression)

Upon completion of the simple logistic regression, variables were selected for multivariate analysis. Variables whose significance had a *p*-value less than 0.05 (Hosmer and Lemeshow, 1989) were considered as candidates for the multivariate analysis, together with age as a variable of known biological importance.

At this point in the statistical analysis the correlations between the significant independent variables were investigated. The correlation was checked by using of cross-tabulation between possibly related variables. Where there was a high inter-correlation of two or more independent variables only one of the variables was chosen for the multivariate analysis.

Table 3 shows significant variables selected by univariate analysis in all four study populations. Variables excluded from the further multivariate logistic regression and variables of known biological importance are marked.

Standard multiple logistic regression

Results from the standard multiple logistic regression, when all significant potential variables for low back pain outcomes and age were entered into the multivariate logistic model together to examine the contribution of all possible variables at the same time, are presented in Table B9.

In taxi drivers, the standard multiple logistic regression revealed that middle height (OR = 2.67), previous physical demands (OR = 2.01), and higher psychosomatic distress levels (medium distress status: OR = 4.53, poor distress status: OR = 7.46) were significantly associated with increased prevalence of low back pain when controlling for other variables presented in Table 3.

In police drivers, multivariate analysis showed that the middle group of age (OR = 2.23), bending at work (OR = 2.19) and a higher level of psychosomatic distress (poor distress status: OR = 2.37) were significantly associated with low back pain when adjusted for other confounders.

In the multiple logistic regression model of the non-driving population, significant associations were found between low back pain and an older age of participants (OR = 2.05), being tall (OR = 2.78), performing bending at work (OR = 1.98), and a higher level of psychosomatic distress (medium distress status OR = 1.61; poor distress status OR = 2.01) .

Pooling information from taxi drivers and police drivers, the multivariate analysis showed that a heavy weight (OR = 2.63), lifting (OR = 1.73) and bending (OR = 1.6) at work, being a police driver (OR = 2.97) and psychosomatic distress (medium distress status OR = 2.39; poor distress status OR = 3.91) are significantly associated with low back pain during the past 12 months when controlling for the effect of other confounders.

In the simple logistic regression, the main part of driving information (e.g. metrics of cumulative exposure to whole-body vibration in taxi drivers or metrics of daily and cumulative exposure to whole body vibration in police drivers) did not show any significant relationship with low back pain experienced during past 12-months. However, standard multiple logistic regression allowed the forcing of the variables into the statistical model. Each aspect of driving information was entered into separate regression models together with all confounders selected by univariate analysis (except any information about driving) to investigate the possible relationships with low back pain.

In multivariate logistic regression, where in addition to driving information other confounders were included, there was an increasing trend in the prevalence of low back pain with increasing duration of driving and increasing vibration exposure expressed in different values.

In the population of taxi drivers, multivariate tests showed an increasing prevalence of low back pain in groups reporting increased daily and cumulative exposure to whole-body vibration. A significant association was found in the driving groups reporting highest daily and cumulative exposure to whole-body vibration (except total duration of driving in years) (i.e. daily driving time expressed in hours: OR = 2.56;

Table 3. Variables selected for multivariate analysis of taxi drivers, police drivers and police non-drivers (cross-sectional study)

Population	Variables selected by univariate analysis	Variables excluded from multivariate analysis	Variables of known biological importance	Variables suitable for multivariate analysis
TAXI DRIVERS	Weight Height Lifting Lifting while bending Lifting while twisting Lifting while bending and twisting Previous physical demands Energy and vitality status Distress status	Lifting while bending Lifting while twisting Lifting while bending and twisting Energy and vitality status	Age	Age Weight Height Lifting Previous physical demands Distress status
POLICE DRIVERS	Age Weight BMI Lifting Lifting while bending Lifting while twisting Bending Support at work Sattisfaction at work Distress status	Lifting while bending Lifting while twisting Lifting while bending and twisting Sattisfaction at work BMI		Age Weight Lifting Bending Support at work Distress status
POLICE NON-DRIVERS	Age Gender Weight Height Bending Distress status			Age Gender Weight Height Bending Distress status
DRIVERS	Age Height Weight Type of occupation Lifting Lifting while bending Lifting while twisting Lifting while bending and twisting Twisting Bending Previous physical demands Distress status Energy and vitality status	Lifting while bending Lifting while twisting Lifting while bending and twisting Energy and vitality status Sattisfaction at work BMI		Age Height Weight Type of occupation Lifting Twisting Bending Previous physical demands Distress status

$A_{sum}(8)$: OR = 2.92; $A_{dom}(8)$: OR = 3.5; $eVDV_{dom}$: OR = 2.81; $eVDV_{Total\text{-}dom}$: OR = 3.13; $\sum[t_i]$: OR = 2.57; $\sum[a_{wsi}t_i]$: OR = 2.67; $\sum[a_{wsi}^2 t_i]$: OR = 2.62; $\sum[a_{wsi}^4 t_i]$: OR = 2.66; $\sum[a_{wqi}t_i]$: OR = 2.6; $\sum[a_{wqi}^2 t_i]$: OR = 2.92 and $\sum[a_{wqi}^4 t_i]$: OR = 2.73).

In the population of police drivers, a significant association between driving information and increased risk of low back pain during the past 12 months was not found.

In the pooled group of drivers no significant association was found between increased prevalence of low back pain experienced for at least one day during the past 12-months and any metric of daily exposure to whole-body vibration. Multivariate tests showed increasing prevalence of low back pain with increasing cumulative exposure to whole-body vibration. A significant association was found in the driving group reporting more than 16 years of driving (OR = 1.64).

Tables B10a and B10b show the relationship between low back pain outcomes and the driving information adjusted for several covariates in taxi drivers, police drivers, and the pooled group of drivers.

<u>Stepwise multiple logistic regression</u>

Stepwise multiple regression was used to identify the subset of independent variables having the strongest relationship to the dependent variable. In this step of the statistical analysis only variables that had been found to be significantly related with low back pain experienced during past 12-months in the simple logistic regression were used. The final results of the stepwise multiple logistic regression are presented in Table B11.

In taxi drivers, the strongest predictors for low back pain during the past 12 months were middle height of drivers (OR = 3.23), heavy physical load in previous work (2.23), and medium and high levels of psychosomatic distress (OR = 4.36, OR = 7.24).

In police drivers, the stepwise multiple logistic regression revealed increasing age of drivers (middle age: OR = 2.31, high age: OR = 2.07), lifting (OR = 1.66) and bending (OR = 2.16) at work, and all levels of psychosomatic distress (medium distress status OR = 2.68; poor distress status OR = 2.39) to be the strongest predictors of low back pain.

Pooling all information from taxi and police drivers showed that increasing weight (OR = 2.88), bending (OR = 1.6) and lifting (OR = 1.7) at work, being a police driver (OR = 2.15) and increased psychosomatic distress (medium distress status OR = 2.34; poor distress status OR = 4.04) were all significantly related to low back pain reported during the past year.

In the non-driving population, increasing height (middle stature OR = 1.64; high stature OR = 2.71), bending (OR = 1.6) and high psychosomatic distress (OR = 1.85) were predictors of low back pain.

3.2. Whole-body vibration measurements

The frequency-weighted acceleration in the *z*-axis (the dominant component of the vibration) was in the range from 0.39 to 0.47 ms^{-2} r.m.s. in the taxis and from 0.36 to 0.58 ms^{-2} r.m.s. in the police vehicles.

The frequency-weighted vibration magnitudes measured in three different types of taxi (a saloon car, a purpose-built and a purpose-adapted taxi, Figure 9) and seven different types of police vehicle (traffic vehicles and squad vehicles, Figure 10) over a 20-minute measurement period are presented in Table B12. Table B12 shows the *x*-, *y*-, and *z*-axis frequency-weighted vibration magnitudes on the seat pan in accord with ISO 2631 (1997).

Vibration exposures (average daily exposure and measures of cumulative exposure) were all significantly greater for the taxi drivers than the police drivers (p<0.001). For examples of daily and cumulative exposure to WBV, see Table B7.

Estimation of real duration of exposure to whole-body vibration in taxi drivers

I. II. III.

Figure 9. Tested taxi vehicles (I. Skoda Octavia, II. TX1, III.Vauxhall Zafira)

I. II. III. IV. V. VI. VII.

Figure 10. Tested police vehicles (I. Land Rover- Discovery, II. Vauxhall Astra, III. Ford Focus, IV. Vauxhall Omega, V. BMW 750, VI. Ford Mondeo, VII. Land Rover- Ranger

Information about the duration of driving provided by each tested taxi driver in the short questionnaire were compared with information obtained from the accelerometers. The duration of measurement and estimation of driving exposure for each driver is listed in Table 4. From six measurements and the recorded details it was found that drivers overestimate their exposure to driving on average by 33 % with a range from 17% to 44%.

Table 4. Comparison of measured and estimated duration of driving in taxi drivers

Driver	Duration of measurement	Driving duration reported by driver	Real duration of driving	Overestimation of drivng
Taxi driver 1	8hrs	6 hrs	4hrs 24 min	36%
Taxi driver 2	8 hrs	5hrs	4hrs 9min	17%
Taxi driver 3	8 hrs	7hrs	4hrs 30min	44%
Taxi driver 4	8hrs	8hrs	5hrs 19min	34%
Taxi driver 5	8hrs	6hrs	4hrs 15min	29%
Taxi driver 6	8 hrs	8hrs	5hrs 19min	34%
TOTAL				33%

3.2. Longitudinal study

3.2.1. Description of the population

Taxi drivers

From the total of 861 questionnaires posted in the first year of the study, 222 responses were returned. From the total of 222 responses, 209 questionnaires were used and 13 cases were excluded because they did not wish to participate in the study or they were no longer taxi drivers.

In the second year of the study, questionnaires were posted to the participants who had participated in the first year of the study. From the total of 209 posted questionnaires 155 responses were returned.

From the total of 155 responses, 11 cases were excluded because they did not wish to participate in the study or they were no longer taxi drivers. In total, 144 questionnaires from taxi drivers were used in the baseline and follow-up of the longitudinal study.

Police employees

From the total of 2105 questionnaires posted in the first year of the study 852 responses were returned. Two cases were excluded because they did not wish to participate in the study. From the total of 850 police employees, 365 were classified as police drivers and 485 were classified as non-drivers.

Police drivers

In the second year of the study, questionnaires were posted to the police drivers who had participated in the first year of the study. From the total of 365 posted questionnaires 219 responses were returned. There was no questionnaire excluded from the study and all 219 responses were used in the baseline and follow-up study.

Police non-drivers

In the second year of the study, questionnaires were posted to the 485 police non-drivers who had participated in the first year of the study. From the total of 302 returned questionnaires, 2 responses were excluded because they were no longer in the police force. In total, 300 questionnaires from police non-drivers were used in the baseline and follow-up of the longitudinal study.

Drivers

Information from taxi drivers and police drivers were pooled together. In total there were 363 questionnaires used in the longitudinal study of drivers.

3.2.2. Incidence and persistence of low back pain in the longitudinal study

Taxi drivers

In the follow-up study, from the total of 144 drivers, 9 (11%) reported a new episode of low back pain during the past 12 months, 2 (3%) reported a new episode of low back pain during the past 4 weeks and 2 (3%) reported a new episode of low back pain during the past 7 days.

A persistent episode of low back pain during the past 12 months was reported in 43 (67%), and 26 (41%) of drivers reported a recurrent episode of low back pain during the past 4 weeks and during the past 7 days.

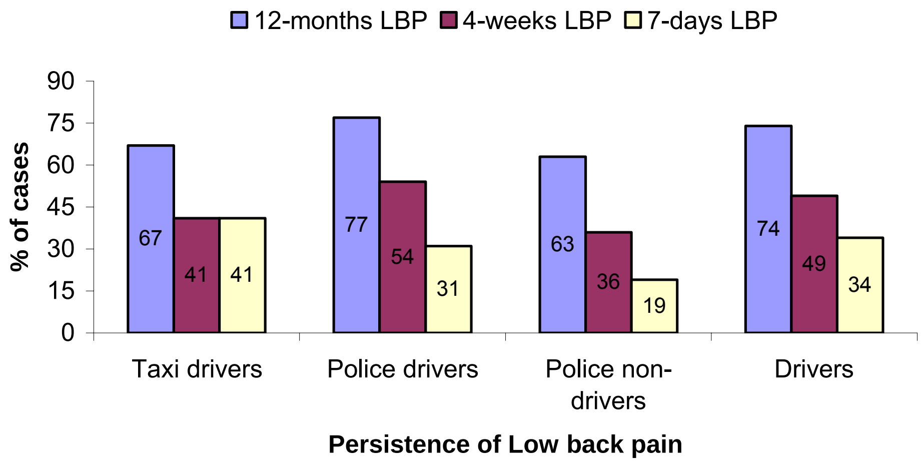

Figure 12. Persistence of low back pain in taxi drivers, police drivers, police non-drivers and pooled group of drivers in the longitudinal study

The incidence and persistence of low back pain among taxi drivers are illustrated graphically in Figure 11-12.

Police drivers

In the follow-up study, from the total of 219 police drivers, 25 (26%) reported a new episode of low back pain during the past 12 months, 11 (11%) reported a new episode of low back pain during the past 4 weeks, and 5 (5%) reported a new episode of low back pain during the past 7 days.

A persistent episode of low back pain during the past 12 months was reported in 95

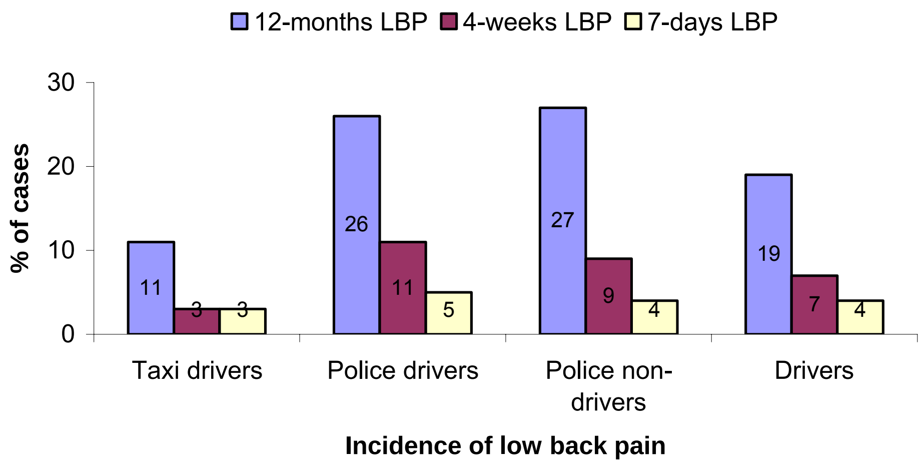

Figure 11. Incidence of low back pain in taxi drivers, police drivers, police non-drivers and pooled group of drivers in the longitudinal study

(77%), 66 (54%) of police drivers during the past 4 weeks, and 38 (31%) of police drivers reported a recurrent episode during the past 7 days.

The incidence and persistence of low back pain among police drivers is illustrated graphically in Figure 11-12.

Police non-drivers

In the follow-up of the study, from the total of 300 police non-drivers, 43 (27%) reported a new episode of low back pain during the past 12 months, 14 (9%) reported a new episode of low back pain during the past 4 weeks, and 7 (4%) reported a new episode of low back pain during the past 7 days.

A persistence episode of low back pain during the past 12 months was reported in 88 (63%), 51 (36%) of police non-drivers reported a recurrent episode of low back pain during the past 4 weeks, and 27 (19%) of police non-drivers reported a recurrent episode during the past 7 days.

The incidence and persistence of low back pain among police non-drivers is illustrated graphically in Figure 11-12.

Drivers

In the follow-up of the study, from the total of 363 drivers, 34 (19%) drivers reported a new episode of low back pain during the past 12 months, 13 (7%) drivers reported a new episode of low back pain during the past 4 weeks and 7 (4%) reported a new episode of low back pain during the past 7 days.

A persistent episode of low back pain during the past 12 months was reported in 138 (74%), 92 (49%) drivers reported recurrent episode of low back pain during the past 4 weeks and 64 (34%) drivers reported recurrent episode of low back pain during the past 7 day.

The incidence and persistence of low back pain among drivers is graphically illustrated in Figure 11-12.

3.2.3. Risk factors for low back pain

The selection of suitable candidate risk factors for the final multivariate analysis in the longitudinal study was based on results from the baseline cross-sectional study.

All risk factors that were selected by stepwise multiple logistic regression in the baseline cross-sectional study were considered to be possible predictors for low back pain and were automatically entered into the final statistical model of the longitudinal study. Possible predictors for low back pain are listed in Table 5.

Multivariate analysis (follow-up of the study)

The multivariate analysis followed separately the participants who reported episodes of low back pain lasting for at least one day during the past 12 months in the baseline of the study (the 'persistence group') and participants who did not report an episode of low back pain during the past 12 months in the baseline of the study (the 'incidence group').

Standard multiple logistic regression

Individual, physical and psychosocial factors

Results of the standard multiple logistic regression, when all significant potential variables for low back pain outcomes (without information on whole-body vibration exposure) and age as variables of known biological importance were entered into the multivariate logistic model together to examine the contribution of all possible variables at the same time, are presented in Tables B13 and B14.

Persistence of low back pain

In taxi drivers, the standard multiple logistic regression revealed that there was increasing persistence of low back pain during the past 12 months with increasing body height (significant in both height groups: OR = 5.55, OR = 16.56) and high psychosomatic distress status (OR = 6.2). Increased risk of low back pain was found in the middle age group of taxi drivers, but the association was not statistically

Table 5. Variables selected for multivariate analysis of taxi drivers, police drivers, police non-drivers, and the pooled group of drivers (follow-up of longitudinal study)

Risk factors selected for multivariate analysis			
Taxi drivers	Police drivers	Police non-drivers	Drivers
Age	Age	Age	Age
Height	Lifting	Height	weight
Physical demands in previous job(s)	Bending	Bending	Lifting
Distress status	Distress status	Distress status	Bending
			Type of occupation
			Distress status
Driving information			

significant (OR = 3.42).

In police drivers, the standard multiple logistic regression only revealed a significantly increased persistence of low back pain in the driving group with poor psychosomatic distress status (OR = 4.76).

In the multiple logistic regression model of the non-driving population, a significantly increased persistence of low back pain was found with performing bending at work (OR = 3.58), and with a middle age group of participants (OR = 3.23). Analysis also revealed a trend for increased persistence of low back pain with increasing height.

Pooling information from taxi drivers and police drivers in the multivariate analysis showed that being a police driver (OR = 2.46) and having a high psychosomatic distress status (OR = 5.27) were significantly associated with low back pain during the past 12 months when controlling for the effect of other confounders.

Incidence of low back pain

Statistical analysis was not undertaken on the incidence group of taxi drivers because the number of new cases was too low (n=9).

In police drivers, the standard multiple logistic regression revealed that there was a significant increased in the incidence of low back pain in the driving group with poor psychosomatic distress status (OR = 5.44) and middle age (OR = 3.21).

In the pooled group of all drivers and non-drivers, the standard multiple logistic regression only revealed a significant increase in the incidence of low back pain in the group with poor psychosomatic distress status (drivers: OR = 5.54; non-drivers: OR = 3.11).

<u>Driving information</u>

Multiple logistic regression allowed the influence of driving information on the persistence and incidence of low back pain to be seen by forcing the relevant variables into the statistical model. Each aspect of driving information (i.e. measures of daily and cumulative vibration exposure) was entered into separate regression models with other confounders selected in the cross-sectional study (except any information about driving). For the list of confounders see Table 5.

Persistence of low back pain

In the persistence group of taxi drivers there was no significant association between increased persistence of low back pain and any variable reflecting driving.

In the persistence group of police drivers and in the pooled group of drivers, the persistence of low back pain experienced during the past 12 months increased with increasing total duration of driving expressed in years. In police driver, a statistically significant increase in the persistence of low back pain was found in those who had driven a police vehicle for more than 15.4 years (OR = 5.95). In pooled group of all drivers, statistically significant increase in the persistence of low back pain was found in those who had driven a vehicle for more than 16 years (OR = 2.58).

Incidence of low back pain

In the 'incidence group' of police drivers, the incidence of LBP increased significantly with increasing daily vibration exposure expressed as duration of driving in hours, $A_{sum}(8)$, $A_{dom}(8)$ and eVDV_{dom}. There were non-significant trends for increased incidence of LBP during the past 12 months with increased cumulative exposure to whole-body vibration (i.e. e$VDV_{Total\text{-}dom}$., $\sum[a_{wsi}t_i]$, $\sum[a_{wsi}^2t_i]$, $\sum[a_{wsi}^4t_i]$, $\sum[a_{wqi}t_i]$, $\sum[a_{wqi}^2t_i]$, and $\sum[a_{wqi}^4t_i]$).

Pooling information from the driving populations showed a non-significant trend for increasing incidence of low back pain with increasing cumulative exposure to driving expressed as e$VDV_{Total\text{-}dom}$., $\sum[a_{wsi}t_i]$, $\sum[a_{wsi}^2t_i]$, $\sum[a_{wsi}^4t_i]$, $\sum[a_{wqi}t_i]$, $\sum[a_{wqi}^2t_i]$, and $\sum[a_{wqi}^4t_i]$.

The final standard multiple logistic regressions including driving information are presented in Tables B15a, B15b, B15c and B15d.

4. DISCUSSION

4.1. Prevalence, incidence and recurrence of low back pain

The 12-month prevalence of low back pain in the baseline cross-sectional study of taxi drivers and police drivers was similar to that found in other studies of driving populations. Generally, epidemiological studies with cross-sectional or case-control designs report 40 to 60% of professional drivers with LBP A study by Magnusson *et al.* (1996) found that 50% of bus drivers and truck drivers reported low back pain. A study of fork-lift truck and freight-container tractor drivers by Boshuizen *et al.* (1992) found the prevalence of low back pain to be 51%. Chen *et al.* (2004) found that 51% of urban taxi drivers reported low back pain in the past year, and Pietri *et al.* (1992) found the one-year prevalence of low back pain among car drivers to be 40%.

In this study, the police drivers (53% in the baseline cross-sectional study) reported a higher 12-month prevalence of low-back pain than taxi drivers (45% in the baseline cross-sectional study). The non-driving population, represented by police employees who reported less than 5 hours of driving per working week, had a similar 12-month prevalence of LBP (46% in the baseline cross-sectional study) to the population of taxi drivers. The prevalence of LBP in the police non-driving population is consistent with the life-time prevalence reported in other epidemiological studies of general populations (e.g. Frymoyer *et al.,* 1983; Damkot *et al.*, 1984; Riihimäki *et al.*, 1989; Masset *et al.*, 1994). However, epidemiological studies of the general population do not always distinguish between professional drivers and those who do not drive in their job.

The greatest rate of new episodes of low back pain (incidence cases) after one year of investigation was in the non-driving population (27%), followed by police drivers (26%), and taxi drivers (11%). The incidence rate of low back pain in the taxi drivers is similar to the incidence of low back pain reported in a study of low back pain in commercial travellers (Pietri *et al.*, 1992), where a 13% incidence rate was found among males and a 17% incidence rate among females. Although the incidence rate was higher in the non-driving population, the greatest rate of persistent low back pain during the past 12 months was among the driving populations (67% in taxi drivers, 77% in police drivers, and 63% in the non-driving population). The 12-month persistence of low back pain in the follow-up study of taxi drivers, police drivers is similar to that found in other studies. Thomas *et al.* (1999) in their study of the development of chronic low back pain reported 34% of persistent pain in the general population. In a study by Tubach *et al.* (2004), the two-year persistence rate of low back pain was 55% and the three-year persistence rate was 53% among the workers of a French electricity and gas company. There are few longitudinal studies (cohort studies) reporting the incidence and persistence of health symptoms among professional drivers, probably because of the loss of subjects during investigation, the high cost of such studies, the high demand on time, etc.

Very approximately, there were similar rates of prevalence, incidence, and persistence of LBP during the past 12 months in police drivers, taxi drivers, and non-drivers. Comparable values of LBP outcomes suggest that the non-drivers were at a similar risk of developing LBP as the drivers.

A limitation of this study is the small number of participants (especially taxi drivers) in the first round of the study. The analysis of replies in the initial baseline cross-sectional study did not show any significant differences between those participants who replied at the initial questionnaire round and those who replied after a reminder and therefore it could be assumed that the study groups are representative samples of selected populations. In the follow-up of the longitudinal study, a higher response rate was obtained by more reminding and an incentive. To enhance the response rate, the taxi drivers were offered a small cash reward to be awarded to five drivers randomly selected from those who answered both questionnaires (baseline and follow-up study). The police employees were informed that a small donation would be paid to their local police charity for each completed questionnaire.

4.2. Whole body vibration exposure

4.2.1 Vibration measurements

In previous studies of taxi drivers, the mean frequency-weighted acceleration in the *z*-axis (the dominant vibration component) was 0.31 ms^{-2} r.m.s. with a range from 0.17 to 0.55 ms^{-2} r.m.s. and from 0.26 to 0.34 ms^{-2} r.m.s (Chen *et al.*, 2003; Funakoshi *et al.,* 2004). In this study, the *z*-axis vibration on the seat was also the dominant vibration component in all measurements in both the taxis and the police vehicles. In the saloon car, which was the type of taxi driven by most taxi drivers in the City of Southampton, the frequency-weighted acceleration in the z-axis was 0.47 ms^{-2} r.m.s. In the police vehicles, the highest frequency-weighted acceleration in the z-axis was measured in one of the general purpose vehicles (0.58 ms^{-2} r.m.s.). The frequency-weighted acceleration on the seat was greater in the present measurements than in the studies of drivers reported by Chen *et al.* and by Funakoshi *et al.* The greater values may reflect differences in driving speeds, road surfaces, and the design of the vehicles. The present vibration measurements are broadly consistent with those reported from a previous study of exposure to whole-body vibration in vehicles in the UK (Paddan and Griffin, 2002). Paddan and Griffin found the mean frequency-weighted acceleration (vertical vibration on the seat) of 25 different cars to be 0.43 ms^{-2} r.m.s., with a range from 0.26 to 0.75 ms^{-2} r.m.s. when evaluated in accord with ISO 2631 (1997).

4.2.2. Overestimation of driving exposure

Low back pain may affect the perceptions workers and their ratings of their work demands. From a review of thirteen studies investigating a possible overestimation of working tasks it has been concluded that workers with low back pain tend to over-estimate their exposures to vibration (Barriera-Viruet *et al.,* 2006). In the case of taxi drivers, if the drivers did not properly distinguish between the periods when they were ‘on duty’ but waiting for passengers and the periods when the vehicle was running, there will have been errors, probably overestimation of vibration exposure duration. From a small study with 8-hour measurements of whole-body vibration it was found that a group of taxi drivers in the City of Southampton overestimated their driving exposure by 33% on average (with a range from 17% to 44%). This overestimation is based on six measurements and will be clarified by results from additional measurements now ongoing.

4.2.3. Driving factors as risks for low back pain

Various alternative indicators of the extent of exposure to whole-body vibration from taxi driving and police driving were investigated.

Cross-sectional study

In the cross-sectional study, a trend for increased prevalence of low back pain during the past 12 months was consistently found with increased daily exposure to driving expressed by several measures in taxi drivers. The cross-sectional study multivariate data analysis showed that increased daily and cumulative life-time vibration dose values were possible predictors of low back pain experienced during the past 12 months.

The cross-sectional study of police drivers did not reveal any statistically significant associations suggesting increased prevalence of low back pain with increased driving.

Longitudinal study

The longitudinal study of taxi drivers did not reveal any statistically significant associations suggesting increased persistence of low back pain with increased driving. In the longitudinal study of police drivers, there was a significant increase in the persistence of low back pain in those who had driven for more than 15.4 years. There was significantly increased incidence of low back pain in police drivers who had increased daily vibration exposure. It was not possible to investigate the incidence of low back pain in taxi drivers because the number of new cases of low back pain during the past 12-months was too low.

4.4. Non-driving risk factors for low back pain

In the longitudinal study, increased psychosomatic distress was a strong predictor of the persistence of lo back pain experienced for at least one day during the past 12 months in all investigated driving populations (i.e. the taxi drivers and the police drivers). Increased psychosomatic distress was also a strong predictor of the incidence back pain in police non-drivers. Similar findings of the importance of psychosocial factors, such as anxiety, depression, and stressful events among individuals with back pain have been identified in other studies (e.g., Bergenudd and Nilsson, 1988; Gallais and Griffin, 2006). It is not clear the extent to which psychosocial problems are the cause of LBP or caused by back pain. There is no evidence linking psychosocial factors to the development of physical pathology of the spine, but people with distress are more likely to develop, or at least report, back pain (Waddell, 1998).

In the taxi drivers, being tall was a significant predictor of persistent back pain. Anthropometric individual factors such as height and weight seem to have an important role in increasing the prevalence of low back pain in some published epidemiological studies. Heliövaara (1987) studied body height, obesity and the risk of herniated lumbar intervertebral disc and found that the body mass index was an independent risk factor in a male population and that height and heavy body mass may be important contributors for disc herniation. Gyntelberg (1974) suggested that taller individuals are at greater risk for low back pain when compared with shorter people. However, some studies have not found that increased body height increases the risk of back pain (see Gallais and Griffin, 2006).

Previous epidemiological studies have found that the prevalence of back problems increases with increasing age (see Gallais and Griffin, 2006). Bovenzi and Betta (1994) in a study of agricultural tractor drivers exposed to whole-body vibration found an association between back problems and age. The lifetime prevalence of low back pain, sciatic pain, and acute low back pain increased with increasing age for tractor drivers and also for control subjects. In a study by Bovenzi (1996) the prevalence of chronic low back pain was found to increase with increasing age for professional drivers, such as bus drivers and tractor drivers, and also for control subjects. In the baseline cross-sectional study it was found that the risk of back pain was higher in the middle age group than in the older and younger age groups, which might be explained by the 'healthy worker effect' in which those with back pain tend to leave the job, resulting in less back pain with increasing age.

In the non-driving population, the risk of persistent back pain was greater in the middle age group than in the oldest and youngest age groups. A significant increase in persistent back pain was also found in the participants reporting bending at work. Similar findings of the importance of bending among individuals with back pain have been identified in other studies (e.g. Riihimäki *et al.*, 1989, Gallais and Griffin, 2006).

4.5. Is the evidence in previous studies or the current study sufficient to

conclude that driving a car is a risk factor for low back pain?

Many epidemiological studies of low back problems in car drivers may be considered unsatisfactory due to lack of information about driving or lack of consideration of the other factors than associated with low back pain (Gallais and Griffin, 2006). Most studies in their literature review concluded there is a relation between low back pain and car driving, but the strength of the evidence on which this conclusion was based varied greatly. A relation between low back pain and car driving would be consistent, but not fully explained by, the conclusion of literature reviews by Bovenzi and Hulshof (1999) and Lings and Leboeuf-Yde (2000). They concluded from previous epidemiological studies that there was evidence of increased prevalence of back problems among those exposed to whole-body vibration, especially long-term exposures. However, the reviewed studies were mainly of driving environments with high levels of whole-body vibration (trucks, tractors, buses, cranes, etc.).

Back problems may arise because those driving a vehicle at work are at increased risk in some other activity or because of some other influencing factor. Among possible risk factors associated with car driving are factors related to car design (e.g. back posture during driving, forces at the feet when operating foot pedals, load from the arms, head posture, back movement, twisting whole reversing, forces during entry and exit from a car, etc.).

One of the potential risk factor for low back pain in drivers is exposure to whole-body vibration. From previously published studies of professional car drivers it is not possible to conclude that different exposures to vibration among car drivers is associated with differences in low back pain. Quantitative relationship between low back pain and exposure to whole-body vibration are not easily established. The cause-effect relationship between low back pain and exposure to vibration while car driving might be better understood if more studies had explored systematically the chronology of the back pain.

5. CONCLUSION

The 12-month prevalence, incidence, and persistence of low back pain (LBP) in the non-driving population was similar to the prevalence, incidence, and persistence of low back pain reported by the driving populations in this study, suggesting that the driving and non-driving populations were at a similar risk of developing low back pain. The 12-month prevalence of low back pain among taxi drivers and police drivers was similar to that in other driving populations (i.e. bus drivers, fork-lift operators, and truck drivers).

In the taxi drivers, increased exposure to whole-body vibration was not an important risk factor for the persistence of low back pain. In the police drivers, increased duration of total life-time driving (expressed in years) was a statistically significant risk factor for increased persistence of low back pain, and increased daily vibration exposure was a statistically significant risk factor for increased incidence of low back pain.

In taxi drivers, police drivers, and in the non-driving population, the presence of low back pain experienced for at least one day during the past 12 months was significantly associated with individual risk factors (e.g. age, height), physical factors (e.g. bending) and, mainly, psychosocial risk factors (i.e. increased psychosomatic distress status).

6. POLICY RELATED BENEFITS

Although from this study it is not possible to exclude whole-body vibration as a risk factor for low back pain in taxi driving and police driving it is clearly not the dominant cause of any low back pain in these drivers. A similar risk of low back pain was present in non-drivers. This suggests that whole-body vibration does not need to be identified as a risk for driving similar to that studied here.

Expressed in terms of vibration dose values, the exposure action value for whole-body vibration is 9.1 $ms^{-1.75}$ and the exposure limit value is 21 $ms^{-1.75}$ in the EU Physical Agents (Vibration) Directive, with both measures assessed in the dominant axis. From their self-reported driving times, it is estimated that the drivers investigated in this study had average daily vibration dose values close to the EU daily exposure action value: 8.34 $ms^{-1.75}$ in taxi drivers and 6.09 $ms^{-1.75}$ in police drivers. Eighteen percent of taxi drivers but no police drivers had vibration exposures greater than the 9.1 $ms^{-1.75}$ exposure action value. No taxi drivers or police driver had an exposure greater than the 21 $ms^{-1.75}$ exposure limit value. The absence of clear evidence of low back pain may suggests the exposure action value is conservative for car driving of the type investigated when exposures are calculated from exposure durations reported by drivers. However, if it is assumed that the drivers overestimated their exposures by 33%, the average daily exposures reduce to 7.55 $ms^{-1.75}$ for taxi drivers and 5.5$ms^{-1.75}$ for police drivers with one of taxi drivers and none of police drivers exceeding the exposure action value and none of taxi drivers and police drivers exceeding the exposure limit value. This is not inconsistent with the implications of the EU Physical Agents (Vibration) Directive for the assessment of the risks associated with car driving.

Expressed in terms of root-mean-square acceleration, the exposure action value for whole-body vibration is a daily *A*(8) of 0.5 ms^{-2} r.m.s. and the exposure limit value is 1.15 ms^{-2} r.m.s. in the EU Physical Agents (Vibration) Directive, with both measures assessed in the dominant axis. The drivers investigated in this study had average daily *A*(8) values below the EU daily exposure action value: 0.44 ms^{-2} r.m.s. in taxi drivers and 0.26 $ms^{-1.75}$ in police drivers. Thirty-nine percent of taxi drivers and no police driver had vibration exposures greater than the 0.5 ms^{-2} r.m.s. exposure action value. No taxi drivers or police driver had an *A*(8) exposure greater than the 1.15 ms^{-2} r.m.s. exposure limit value. The absence of clear evidence of low back pain suggests the *A*(8) exposure action value may be conservative for car driving of the type investigated when exposures are calculated from exposure durations reported by drivers. If it is assumed that the drivers overestimated their exposure by 33%, the average daily exposure action values reduce to 0.37 ms^{-2} r.m.s. for taxi drivers and 0.26 ms^{-2} r.m.s. for police drivers with 3% of taxi drivers and none of police drivers exceeding the exposure action value and none of taxi drivers or police drivers exceeding the exposure limit value. This still suggests that the EU Physical Agents (Vibration) Directive is conservative when assessing the risks associated with car driving.

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APPENDIX A

SERIAL NO: G

MEDICAL RESEARCH COUNCIL

HUMAN FACTORS RESEARCH UNIT

Survey of Work Activities and Health

The answers given on this form are confidential.
Replies will ONLY be seen by the small research team.

SECTION A: ABOUT YOURSELF

1. Please fill in your date of birth — Day ☐☐ Month ☐☐ Year ☐☐☐

2. *and* your sex — Male ☐ Female ☐

3. Please record your height *and* your weight — Height ☐ ft ☐☐ in or ☐☐☐ cm

Weight ☐☐ st ☐☐ lbs or ☐☐☐ kg

4. Please indicate your ethnic origin by ticking the appropriate box — ☐ White (European) ☐ Other (please specify) ____________

5. Have you ever **smoked** regularly (i.e. at least once a day for a month or longer? *If **NO**, please go to question 6.* — No ☐ Yes ☐

5a. If ***YES,*** how old were you when you **first** smoked regularly? — ☐☐ years

5b. Do you **still** smoke regularly? — No ☐ Yes ☐

5c. If ***NO***, how old were you when you **last** smoked regularly? — ☐☐ years

6. Do you exercise regularly? *If **NO**, please go to question 8.* — No ☐ Yes ☐

6a. If ***YES***, how often each week do you exercise sufficient to raise a sweat?

Less than 1 time ☐ 1 or 2 times ☐ 3 times ☐ More than 3 times ☐

7. During your leisure time, do you have any sport or hobbies, which expose your body to vibration (e.g. motorcycle biking, rally driving, motor boat driving, etc.)?

No ☐ Yes ☐ *If No, please go to question 8.*

7a. If *Yes*, please specify which type of sport or hobby is it ______________________________

7b. How many <u>hours per week</u> do you practise a sports or hobby that exposes your body to vibration?

Less than an hour ☐ 1 - 3 hours ☐ More than 3 hours ☐

8. How many <u>hours per week</u> do you spend sitting during an average day **outside work**?

Less than an hour ☐ 1 - 3 hours ☐ More than 3 hours ☐

9. How many <u>hours per week</u> do you spend walking during an average day **outside work**?

Less than an hour ☐ 1 - 3 hours ☐ More than 3 hours ☐

10. How many times do you lift loads greater than 15 kg (30 lbs) during an average day **outside work**?

Not at all ☐ 1 - 10 times ☐ More than 10 times ☐

11. About how many miles do you drive each year **outside work** (in your own time)?*(Include any journeys to and from work)*

Less than 5,000 ☐ 5,000- 15,000 ☐ More than 15,000 ☐

SECTION B: YOUR CURRENT JOB

12. When did you start your current job? Month ☐☐ Year ☐☐☐☐

13. How many hours per week do you work in this job? ☐☐ hours

Your views about your job

14. In your job, do you have a choice in deciding:

		Often	*Sometimes*	*Seldom*	*Never/almost never*
a)	**How** you do your work?	☐	☐	☐	☐
b)	**What** you do at work?	☐	☐	☐	☐
c)	Your work timetable and breaks?	☐	☐	☐	☐

15. When you have difficulties in your work, how often do you get help and support from your colleagues or immediate line manager?

Often ☐ Sometimes ☐ Seldom ☐ Never ☐ Not applicable ☐

16. How satisfied have you been with your job as a whole, taking everything into consideration?

Very satisfied ☐ Satisfied ☐ Dissatisfied ☐ Very dissatisfied ☐

Activities in your job

*We are interested in the physical activities that you carry out in **an average working day** in the job. Please think about the pattern of activity in a typical work day and tick the most appropriate box(es).*

Lifting

17. How many **times** in an average working day do you lift loads greater than 15 kg (30 lbs) – e.g. an average child of three or a small suitcase with belongings?

Not at all ☐ 1 - 10 times ☐ More than 10 times ☐

*If **Not at all**, please go to question 19.*

18. And how many **times** in an average working day do you lift such a load **whilst your back is in a bent position**, as shown?

Not at all ☐ 1 - 10 times ☐ More than 10 times ☐

18a. And how many **times** in an average working day do you lift such a load **whilst your back is in a twisted position**, as shown?

Not at all ☐ 1 - 10 times ☐ More than 10 times ☐

18b. And how many **times** in an average working day do you lift such a load **whilst your back is in a bent and twisted position**, as shown?

Not at all ☐ 1 - 10 times ☐ More than 10 times ☐

Digging

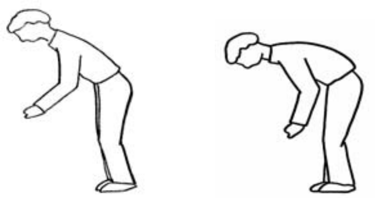
19. Does an average working day involve digging or shovelling? No ☐ Yes ☐

Posture

20. During an average day in the job, how many hours in total are spent standing or walking?

None ☐ Less than an hour ☐ 1 - 3 hours ☐ More than 3 hours ☐

21. Does an average working day involve bending as shown below (other than while lifting)?



No ☐ Yes ☐

*If **NO**, please go to question 22.*

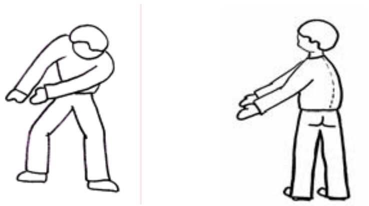
21a. If ***YES***, how many times in an average working day do you bend over in such a position?

Less than 5 times ☐ 5 - 20 times ☐ more than 20 times ☐

21b. And, if you add together all the time in an average working day that you spend in such a position, how many hours does that make?

Less than an hour ☐ 1 - 3 hours ☐ More than 3 hours ☐

22. Does an average day in the job involve twisting as shown below (other than while lifting)?



No ☐ Yes ☐

*If **NO**, please go to question 23.*

22a. If ***YES,*** how many times in an average working day do you twist like this?

Less than 5 times ☐ 5 - 20 times ☐ more than 20 times ☐

22b. And, if you add together all the time in an average working day that you spend in such a twisted position, how many hours does that make?

Less than an hour ☐ 1 - 3 hours ☐ More than 3 hours ☐

23. Does an average working day involve sitting for longer than three hours at a time?

No ☐ Yes, but I **can** get up and move around when I want to ☐ Yes, but I **cannot** get up and move around even if I want to ☐

24. During an average working day, how many hours in total are spent sitting - other than sitting in a vehicle?

Less than an hour ☐ 1 - 3 hours ☐ More than 3 hours ☐

25. During an average working day, how many hours in total are spent sitting in a stationary vehicle?

Less than an hour ☐ 1 - 3 hours ☐ More than 3 hours ☐

26. During an average working day, how many hours in total are spent sitting in a vehicle driven by someone else?

Less than an hour ☐ 1 - 3 hours ☐ More than 3 hours ☐

27. During an average working day, how many hours in total are spent driving (include only the time you are driving the vehicle)?

Less than an hour ☐ 1 - 3 hours ☐ More than 3 hours ☐

(If your job does not involve driving for more than 1 hour per day, please go straight to question 33)

Professional Driving

28. Which type of the vehicles do you normally drive in the job, and for how many hours per week on average?

	Tick if driven in the job	*Total driving time (per week): time vehicle is being driven* hrs	mins
a) Traffic vehicle/ High-speed vehicle (e.g. Vauxhall Omega, Volvo, Range Rover/ Discovery)	☐	☐☐	☐☐
b) Squad car driver (e.g. Vauxhall Astra or Ford Focus)	☐	☐☐	☐☐
d) Other (please specify) ______________________	☐	☐☐	☐☐

29. Do you ever have to drive with your back bent forward or twisted in the job? Seldom/never ☐ Often ☐

30. Do you regularly have to load or unload the vehicle(s) you drive by moving heavy materials or equipment by hand?

No ☐ Yes ☐

31. During a typical working week, how much of the time do you spend driving off road in your job?

Not at all ☐ Less than an hour ☐ 1 - 3 hours ☐ More than 3 hours ☐

32. Does the vehicle you normally drive have automatic gears? No ☐ Yes ☐

SECTION C: OTHER JOBS YOU MAY HAVE HELD

*Complete this section **only** if you have held other jobs in the past. **Otherwise go to Section D.***

33. We are interested in your previous work – including, the kind of job, when it was done, and whether or not it involved professional driving. Please fill in the table below to show **all of the jobs you've held for a year or more**.

Ignore the job you may have told us about in Section B. But include all the other jobs held for a year or more, beginning with the first job after leaving school or higher education.

Age started	Age stopped	Occupation	Which vehicle(s) did you drive professionally in the job? (✓) *(Do not include journeys to and from work)*								
			None	Car or van	Bus or lorry	Motor-cycle	Fork-lift truck	Tractor	Loader	Dump or excavator	Other large vehicle (describe)
☐☐ *age in years*	☐☐ *age in years*	________	☐	☐	☐	☐	☐	☐	☐	☐	☐________
☐☐ *age in years*	☐☐ *age in years*	________	☐	☐	☐	☐	☐	☐	☐	☐	☐________
☐☐ *age in years*	☐☐ *age in years*	________	☐	☐	☐	☐	☐	☐	☐	☐	☐________
☐☐ *age in years*	☐☐ *age in years*	________	☐	☐	☐	☐	☐	☐	☐	☐	☐________

Please check that the table includes all jobs held for a year or more (excluding any current one). If you need more space attach an extra sheet here.

34. Did your previous job(s) involve prolonged sitting (other then when driving)? No☐ <1 hr/day ☐ 1-3 hrs/day ☐ >3 hrs/day☐

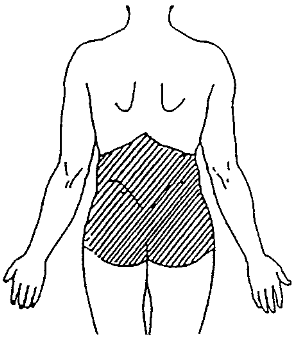
35. Did your previous job(s) involve heavy physical demands (e.g. frequent heavy lifting) ? No ☐ Yes ☐

SECTION D: YOUR HEALTH: ACHES AND PAINS

*This section concerns **aches and pains** you may have had in different parts of the body and at different times.*

The first few questions focus on pain in the LOW BACK in the past 12 MONTHS

36. During the **past 12 months** have you had **back pain** in the area shown in the diagram, which lasted more than a day? *(Don't include pain occurring only during pregnancy, menstrual periods or the course of a feverish illness such as 'flu.)*



No ☐ Yes ☐

*If **NO**, go straight to question 52.*

36a. How long in total during the **past 12 months** has this low back pain been present? *(Tick one.)*

1 - 2 days ☐ 3 - 6 days ☐ 7 - 30 days ☐
1 - 3 months ☐ More than 3 months ☐

37. How much time in total have you taken off work in the **past 12 months** because of low back pain?

None ☐ 1 - 6 days ☐ 7 - 14 days ☐
15 - 30 days ☐ 1 - 3 months ☐ More than 3 months ☐

38. Have you visited a doctor because of this low back pain during the **past 12 months**? No ☐ Yes ☐

39. Has the pain spread down your leg to below your knee during the **past 12 months**? No ☐ Yes ☐

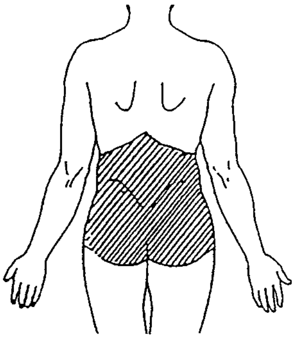
40. Has the pain made it difficult or impossible to put on your shoes, socks, stockings, or tights during the **past 12 months**? No ☐ Yes ☐

41. Do you get back pain while driving? No ☐ Yes ☐

42. Do you get back pain shortly after driving? No ☐ Yes ☐

Your back in the PAST 4 WEEKS

43. During the **past 4 weeks** have you had **low back pain** (as shown in the diagram) which lasted more than a day? *(Don't include pain occurring only during pregnancy, menstrual periods or the course of a feverish illness such as 'flu.)*



No ☐ Yes ☐

*If **NO**, go straight to question 49.*

44. These questions are about the way your back pain is affecting your daily life. We would like to know if you are, or have been <u>in the past 4 weeks</u> in any of the situations listed below (please tick all the items that apply).

	Because of my back:	*No*	*Yes*
a)	I stay at home most of the time because of my back.	☐	☐
b)	I change position frequently to try and get my back comfortable.	☐	☐
c)	I walk more slowly than usual because of my back.	☐	☐
d)	Because of my back, I am not doing any of the jobs that I usually do around the house.	☐	☐
e)	Because of my back, I use a handrail to get upstairs.	☐	☐
f)	Because of my back, I lie down to rest more often.	☐	☐
g)	Because of my back, I have to hold onto something to get out of an easy chair.	☐	☐
h)	Because of my back, I try to get other people to do things for me.	☐	☐
i)	I get dressed more slowly than usual because of my back.	☐	☐
j)	I only stand up for short periods of time because of my back.	☐	☐
k)	Because of my back, I try not to bend or kneel down.	☐	☐
l)	I find it difficult to turn over in bed because of my back.	☐	☐
m)	My back is painful almost all the time.	☐	☐
n)	I find it difficult to get out of a chair because of my back.	☐	☐
o)	My appetite is not very good because of my back pain.	☐	☐
p)	I have trouble putting on my socks (or tights) because of the pain in my back.	☐	☐
q)	I only walk short distances because of my back pain.	☐	☐
r)	I sleep less well because of my back pain.	☐	☐
s)	Because of my back pain, I get dressed with help from someone else.	☐	☐
t)	I sit down for most of the day because of my back.	☐	☐
u)	I avoid heavy jobs around the house because of my back.	☐	☐
v)	Because of my back pain, I am more irritable and bad tempered with people than usual.	☐	☐
w)	Because of my back pain, I go upstairs more slowly than usual.	☐	☐
x)	I stay in bed most of the time because of my back.	☐	☐

And now your back in the PAST 7 DAYS

45. During the **past 7 days** have you had **low back pain**, which lasted more than a day? *If **NO**, go to question 49.* No ☐ Yes ☐

45a. If ***YES***, has the pain spread down your leg to below your knee during the **past 7 days**? No ☐ Yes ☐

46. Has the back pain made it difficult or impossible for you to put on shoes, socks or tights in the **past 7 days**? No ☐ Yes ☐

47. Have you had any time off work because of back pain in the **past 7 days**? No ☐ Yes ☐

48. How would you rate your low back pain on a 0 - 10 scale during a typical day in the **past 7 days** (where **0 = no pain** and **10 = worst pain you can imagine**)?

(Please circle one number.)

No pain ... *Worst pain you can imagine*

0 1 2 3 4 5 6 7 8 9 10

Finally your back when symptoms FIRST BEGAN

49. When this low back pain **first** started, did it come on gradually or suddenly?

Gradually ☐ Suddenly outside work ☐ Suddenly at work ☐

50. *If* this came **suddenly**, when did you first experience it? Year ☐☐

50a. And if **suddenly**, what were you doing at the time? ______________________________

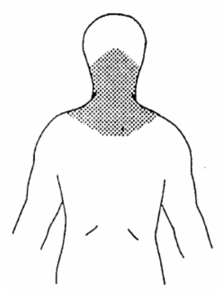
51. Have you ever had an accident to your back that required medical advice? *If NO, go to question 52.* No ☐ Yes ☐

51a. If ***YES***. What type of accident? ______________________________

51b. When did it happen? Year ☐☐

The next few questions focus on pain in your NECK

52. During the **past 12 months** have you had **neck pain** (in the area shown in the diagram) which lasted more than a day?



No ☐ Yes ☐

*If **NO**, go straight to question 59.*

52a. How long in total during the **past 12 months** has this neck pain been present? *(Tick one.)*

1 - 2 days ☐ 3 - 6 days ☐ 7 - 30 days ☐
1 - 3 months ☐ More than 3 months ☐

53. How much time in total have you taken off work in the **past 12 months** because of neck pain?

None ☐ 1 - 6 days ☐ 7 - 14 days ☐
15 - 30 days ☐ 1 - 3 months ☐ More than 3 months ☐

54. Have you had this neck pain during the **past 4 weeks**? No ☐ Yes ☐

55. Have you visited a doctor because of this neck pain during the **past 12 months**? No ☐ Yes ☐

56. Have you had neck pain, which lasted a day or more in the **past 7 days**? *If **NO**, go to question 57.* No ☐ Yes ☐

56a. If ***YES***, how would you rate your neck pain on a 0 - 10 scale during a typical day in the **past 7 days** (where **0 = no pain** and **10 = worst pain you can imagine**)? *(Please circle one number)*

No pain *Worst pain you can imagine*

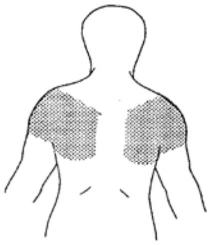
0 1 2 3 4 5 6 7 8 9 10

57. Do you get neck pain while driving? No ☐ Yes ☐

58. Do you have neck pain shortly after driving? No ☐ Yes ☐

Finally, in this section, some questions about pain in your SHOULDER(S)

59. During the **past 12 months** have you had **shoulder pain** (in the area shown in the diagram), which lasted more than a day?



No ☐ Yes ☐

*If **NO**, go straight to question 67.*

59a. How long in total during the **past 12 months** has this shoulder pain been present? *(Tick one.)*

1 - 2 days ☐ 3 - 6 days ☐ 7 - 30 days ☐
1 - 3 months ☐ more than 3 months ☐

60. How much time in total have you taken off work in the **past 12 months** because of shoulder pain?

None ☐ 1 - 6 days ☐ 7 - 14 days ☐
15 - 30 days ☐ 1 - 3 months ☐ More than 3 months ☐

61. Have you visited a doctor because of this shoulder pain during the **past 12 months**? No ☐ Yes ☐

62. Have you had this shoulder pain during the **past 4 weeks**? *If **NO**, go to question 65.* No ☐ Yes ☐

63. During the **past 4 weeks**, when your shoulder pain was **at its worst**, how much difficulty did you have with the following activities? *(Please tick all the activities that apply.)*

Activities	*No difficulty*	*Difficult*	*Impossible*
a) Sleeping	☐	☐	☐
b) Getting dressed	☐	☐	☐
c) Carrying bags	☐	☐	☐
d) Opening doors	☐	☐	☐
e) Routine jobs around the house	☐	☐	☐

64. Have you had shoulder pain lasting a day or more in the **past 7 days**? *If **NO**, go to question 65.* No ☐ Yes ☐

64a. If ***YES***, how would you rate your shoulder pain on a 0 - 10 scale during a typical day in the **past 7 days** (where **0 = no pain** and **10 = worst pain you can imagine**)?

(Please circle one number.)

No pain *Worst pain you can imagine*

0 1 2 3 4 5 6 7 8 9 10

65. Do you get shoulder pain while driving? No ☐ Yes ☐

66. Do you get shoulder pain shortly after driving? No ☐ Yes ☐

SECTION E: OTHER SYMPTOMS AND FEELINGS

*This section concerns **other symptoms** and your **feelings** about health problems.*

67. Firstly, some questions about how you feel and how things have been with you **during the past 4 weeks**. *Please tick the <u>one box</u> for each question which most closely reflects how you feel.*

How much of the time **during the past 4 weeks** …….	*None of the time*	*A little of the time*	*Some of the time*	*Most of the time*	*All of the time*
a) …did you feel full of life?	☐	☐	☐	☐	☐
b) …have you been a very nervous person?	☐	☐	☐	☐	☐
c) …have you felt so down in the dumps that nothing could cheer you up?	☐	☐	☐	☐	☐
d) …have you felt calm and peaceful?	☐	☐	☐	☐	☐
e) …did you have a lot of energy?	☐	☐	☐	☐	☐
f) …have you felt downhearted and low?	☐	☐	☐	☐	☐
g) …did you feel worn out?	☐	☐	☐	☐	☐
h) …have you been a happy person?	☐	☐	☐	☐	☐
i) …did you feel tired?	☐	☐	☐	☐	☐

68. During the past **12 months**, how many days of sick leave have you taken (for all reasons combined)?

None ☐ 1 - 2 days ☐ 3 - 6 days ☐
7 - 30 days ☐ 1 - 3 months ☐ More than 3 months ☐

69. Below is a list of problems people sometimes have. Please read each one carefully and circle the number that best describes how much that problem has distressed or bothered **you** during the **past 7 days including today**.

		Not at all	*A little bit*	*Moderately*	*Quite a bit*	*Extremely*
a)	Faintness or dizziness.	0	1	2	3	4
b)	Pains in the heart or chest.	0	1	2	3	4
c)	Your feelings being easily hurt.	0	1	2	3	4
d)	Feeling that people are unfriendly or dislike you.	0	1	2	3	4
e)	Feeling inferior to others.	0	1	2	3	4
f)	Nausea or upset stomach.	0	1	2	3	4
g)	Trouble getting your breath.	0	1	2	3	4
h)	Numbness or tingling in parts of your body.	0	1	2	3	4
i)	Feeling weak in parts of your body.	0	1	2	3	4
j)	Feeling very self-conscious with others.	0	1	2	3	4

70. <u>Whether you have back pain or not</u>, based on your own views and what the doctor or others may have told you about pain in the back, how strongly do you agree with the following statements?

Please circle one number for each statement which most closely reflects how you feel.
(1 means you completely disagree, 5 means you completely agree)

		Completely disagree				*Completely agree*
a)	Physical activity worsens back pain.	1	2	3	4	5
b)	Physical activities should be avoided if they might make the pain worse.	1	2	3	4	5
c)	An increase in pain is an indication to stop what one is doing.	1	2	3	4	5
d)	Rest is needed to get better.	1	2	3	4	5
e)	Normal work should be avoided until the pain is treated.	1	2	3	4	5
f)	It is important to see a doctor straight away at the first sign of trouble.	1	2	3	4	5
g)	Neglecting problems of this kind can cause permanent health problems.	1	2	3	4	5
h)	Back pain normally gets better by itself.	1	2	3	4	5

You have finished. Please take a moment to look through your answers. Return the questionnaire to us in the pre-paid envelope supplied. Once again thank you for your time and help.

SERIAL NO: S2

MEDICAL RESEARCH COUNCIL

HUMAN FACTORS RESEARCH UNIT

Southampton Survey of Work Activities and Health

The answers given on this form are confidential.
Replies will ONLY be seen by the small research team

Please fill in today's date ☐☐ *day* ☐☐ *month* ☐☐☐☐ *year*

SECTION A: ABOUT YOURSELF

1. Please fill in your date of birth ☐☐ *day* ☐☐ *month* ☐☐☐☐ *year*

2. Please record your weight ☐☐ st ☐☐ lbs or ☐☐☐ kg

3. Do you **smoke** regularly (i.e. at least once a day for a month or longer)? No ☐ Yes ☐

4. Do you exercise regularly? *If **NO**, please go to question 5.* No ☐ Yes ☐

4a. If ***YES***, how often each week do you exercise sufficient to raise a sweat?

Less than 1 time ☐ 1 or 2 times ☐ 3 times ☐ More than 3 times ☐

SECTION B: YOUR CURRENT JOB

5. Has there been any change in job activities since you completed the last questionnaire 12 months ago?

No ☐ Yes ☐ *If **NO**, please go to question 6.*

If *YES*, new job title ________________________

If *YES* what was the cause you have changed your job? ________________________

6. Do you work as a taxi driver Full-time ☐ Part-time ☐ ?

7. Which type of vehicle do you normally drive in the job and for how many hours per week on average?

Type of vehicle	*Tick if driven in the job*	*Total driving time (per week)** *hrs*	*mins*
a) Purpose build taxi (TX1, TX2, Fairway, Metrocab, etc.)	☐	☐☐	☐☐
b) Purpose adapted taxi (Peugeot E7, Fiat Eurocab, etc.)	☐	☐☐	☐☐
c) Saloon car (Mondeo, Vectra, BMW 5, Volvo, etc.)	☐	☐☐	☐☐
d) MPV (Renault Scenic, etc.)	☐	☐☐	☐☐
e) Other (please specify) ________________________	☐	☐☐	☐☐

** Total driving time (per week): time vehicle is being driven*

ACTIVITIES IN YOUR JOB

*We are interested in the physical activities that you carry out in **an average working day** in your job as a taxi driver. Please think about the pattern of activity in a typical work day and tick the most appropriate box(es).*

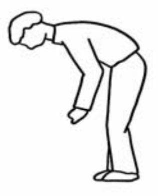
Lifting

8. How many **times** in an average working day do you lift loads greater than 15 kg (30 lbs) - e.g. an average child of three or a small suitcase with belongings?

Not at all ☐ 1 - 10 times ☐ More than 10 times ☐

*If **Not at all**, please go to question 10.*

9. And how many **times** in an average working day do you lift such a load **whilst your back is in a bent position**, as shown?



Not at all ☐ 1 - 10 times ☐ More than 10 times ☐

9a. And how many **times** in an average working day do you lift such a load **whilst your back is in a twisted position**, as shown?

Not at all ☐ 1 - 10 times ☐ More than 10 times ☐

9b. And how many **times** in an average working day do you lift such a load **whilst your back is in a bent and twisted position**, as shown?

Not at all ☐ 1 - 10 times ☐ More than 10 times ☐

Digging

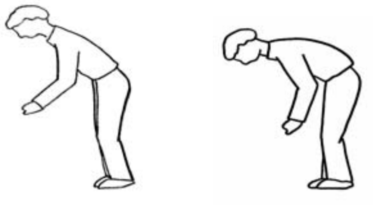
10. Does an average working day involve digging or shovelling? No ☐ Yes ☐

Posture

11. During an average day in the job, how many hours in total are spent standing or walking?

None ☐ Less than an hour ☐ 1 - 3 hours ☐ More than 3 hours ☐

12. Does an average working day involve bending as shown below (<u>other as while lifting</u>)?



No ☐ Yes ☐

*If **NO**, please go to question 13.*

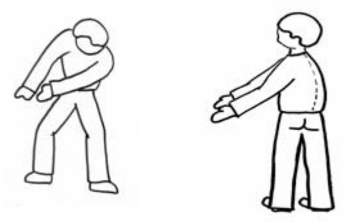
12a. If ***YES***, how many times in an average working day do you bend over in such a position?

Less than 5 times ☐ 5 - 20 times ☐ More than 20 times ☐

12b. And, if you add together all the time in an average working day that you spend in such a position, how many hours does that make?

Less than an hour ☐ 1 - 3 hours ☐ More than 3 hours ☐

13. Does an average day in the job involve twisting as shown below (<u>other as while lifting</u>)?



No ☐ Yes ☐

*If **NO**, please go to question 14.*

13a. If ***YES,*** how many times in an average working day do you twist like this?

Less than 5 times ☐ 5 – 20 times ☐ More than 20 times ☐

13b. And, if you add together all the time in an average working day that you spend in such a twisted position, how many hours does that make?

Less than an hour ☐ 1 – 3 hours ☐ More than 3 hours ☐

14. During an average working day, how many hours in total are spent sitting <u>(other than when driving but including periods when you sit in your vehicle but are not driving</u>)?

Less than an hour ☐ 1 - 3 hours ☐ More than 3 hours ☐

15. Does an average working day involve sitting for longer than three hours at a time?

No ☐ Yes, but I **can** get up and move around when I want to ☐ Yes, but I **cannot** get up and move around even if I want to ☐

16. During an average working day, how many hours in total are spent driving (include only the time vehicle is being driven)?

Less than an hour ☐ 1 - 3 hours ☐ More than 3 hours ☐

17. Do you ever have to drive with your back bent forward or twisted in the job?

Seldom/never ☐ Often ☐

18. During a typical working week, how much of the time do you spend driving off road in your job?

Not at all ☐ Less than an hour ☐ 1 - 3 hours ☐ More than 3 hours ☐

Your views about your job

19. In your job, do you have a choice in deciding:

	Often	*Sometimes*	*Seldom*	*Never/almost never*
a) **How** you do your work?	☐	☐	☐	☐
b) **What** you do at work?	☐	☐	☐	☐
c) Your work timetable and breaks?	☐	☐	☐	☐

20. When you have difficulties in your work, how often do you get help and support from your colleagues or immediate line manager?

Often ☐ Sometimes ☐ Seldom ☐ Never ☐ Not applicable ☐

21. How satisfied have you been with your job as a whole, taking everything into consideration?

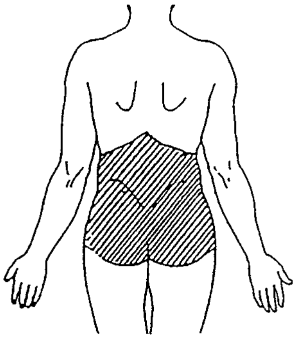
Very satisfied ☐ Satisfied ☐ Dissatisfied ☐ Very dissatisfied ☐

SECTION C: YOUR HEALTH: ACHES AND PAINS

We are interested in knowing whether you have had ***aches and pains*** *since we last contacted you, about 12 months ago.*

The first few questions focus on pain in the LOW BACK.

22. Since answering our questionnaire approximately 12 months ago, have you had **back pain** in the area shown in the diagram, which lasted more than a day? *(Don't include pain occurring only during pregnancy, menstrual periods or the course of a feverish illness such as 'flu).*



No ☐ Yes ☐

*If **NO**, go straight to question 33, page 9.*

22a. If ***YES***, how long in total **since we last questioned you**, has this low back pain been present? *(Tick one.)*

1 - 2 days ☐ 3 - 6 days ☐ 7 - 30 days ☐
1 - 3 months ☐ More than 3 months ☐

23. How much time in total have you taken off work **since we last questioned you**, because of low back pain?

None ☐ 1 - 6 days ☐ 7 - 14 days ☐
15 - 30 days ☐ 1 - 3 months ☐ More than 3 months ☐

24. Have you visited a doctor or other health care professional because of this low back pain **since we last questioned you**? No ☐ Yes ☐

25. Has the pain spread down your leg to below your knee **since we last questioned you**? No ☐ Yes ☐

26. Do you get back pain while driving? No ☐ Yes ☐

27. Do you get back pain shortly after driving? No ☐ Yes ☐

28. **Since we last questioned you**, have you had to cut down or avoid any of the following activities in your job because of low back pain?

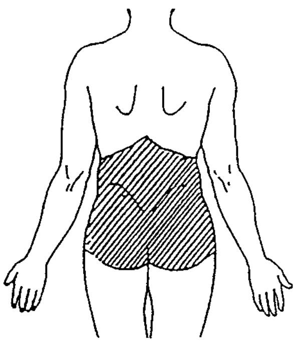
(Please tick one box for each line.)

	Not needed to cut down/avoid this activity	*Had to cut down/avoid because of back pain*	*This activity is not normally part of the job*
a) Lifting loads greater than 10 kg (20lbs).	☐	☐	☐
b) Lifting while your back is bent or twisted.	☐	☐	☐
c) Working with your hands above shoulder height.	☐	☐	☐
d) Working as a professional driver (ie driving in the job for an hour or more on most work days).	☐	☐	☐
e) Prolonged standing or walking in the job.	☐	☐	☐

Your back in the PAST 4 WEEKS

The next few questions focus on your back in the ***past 4 weeks****.*

29. During the **past 4 weeks** have you had **low back pain** (as shown in the diagram) which lasted more than a day? *(Don't include pain occurring only during pregnancy, menstrual periods or the course of a feverish illness such as 'flu).*



No ☐ Yes ☐

If ***NO****, go straight to question 31, page 9.*

29a. If ***YES***, these questions are about the way your back pain is affecting your daily life. We would like to know if you are, or have been in the **past 4 weeks**, in any of the situations listed below.

(Please tick all the items that apply.)

		No	*Yes*
a)	I stay at home most of the time because of my back.	☐	☐
b)	I change position frequently to try and get my back comfortable.	☐	☐
c)	I walk more slowly than usual because of my back.	☐	☐
d)	Because of my back I am not doing any of the jobs that I usually do around the house.	☐	☐
e)	Because of my back, I use a handrail to get upstairs.	☐	☐
f)	Because of my back, I lie down to rest more often.	☐	☐
g)	Because of my back, I have to hold onto something to get out of an easy chair.	☐	☐
h)	Because of my back, I try to get other people to do things for me.	☐	☐
i)	I get dressed more slowly than usual because of my back.	☐	☐
j)	I only stand up for short periods of time because of my back.	☐	☐
k)	Because of my back, I try not to bend or kneel down.	☐	☐
l)	I find it difficult to turn over in bed because of my back.	☐	☐
m)	My back is painful almost all the time.	☐	☐
n)	I find it difficult to get out of a chair because of my back.	☐	☐
o)	My appetite is not very good because of my back pain.	☐	☐
p)	I have trouble putting on my socks (or tights) because of the pain in my back.	☐	☐
q)	I only walk short distances because of my back pain.	☐	☐
r)	I sleep less well because of my back pain.	☐	☐
s)	Because of my back pain, I get dressed with help from someone else.	☐	☐
t)	I sit down for most of the day because of my back.	☐	☐
u)	I avoid heavy jobs around the house because of my back.	☐	☐
v)	Because of my back pain, I am more irritable and bad tempered with people than usual.	☐	☐
w)	Because of my back pain, I go upstairs more slowly than usual.	☐	☐
x)	I stay in bed most of the time because of my back.	☐	☐

And now your back in the PAST 7 DAYS

30. If you had **low back pain**, how would you rate it on a 0 **-** 10 scale during a typical day in the **past 7 days** (where **0 = no pain** and **10 = worst pain you can imagine**)?

(Please circle one number.)

No pain *Worst pain you can imagine*

0 1 2 3 4 5 6 7 8 9 10

Pattern of back pain

31. Were you getting this low back pain at the time you last answered our questionnaire? No ☐ Yes ☐

*If **YES,** go to question 33, if **NO** please continue.*

32. a) **When** did the pain start? ☐☐ months *or* ☐☐ weeks ago

b) **How** did the pain start? Suddenly ☐ Gradually ☐

If suddenly,

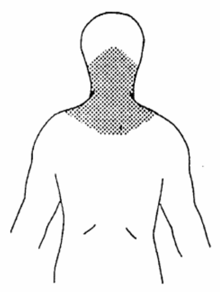
c) Where were you when the pain started? At work ☐ At home or elsewhere ☐

d) And what were you doing when the pain started? ______________________________

____

The next few questions focus on pain in your NECK

33. Since answering our questionnaire approximately 12 months ago, have you had **neck pain** (in the area shown in the diagram), which lasted more than a day?



No ☐ Yes ☐

*If **NO**, go straight to question 39, page 10.*

33a. If ***YES,*** how long in total **since we last questioned you**, has this neck pain been present? *(Tick one.)*

1 - 2 days ☐ 3 - 6 days ☐ 7 - 30 days ☐
1 - 3 months ☐ More than 3 months ☐

34. How much time in total have you taken off work **since we last questioned you**, because of neck pain?

None ☐ 1 - 6 days ☐ 7 - 14 days ☐
15 - 30 days ☐ 1 - 3 months ☐ More than 3 months ☐

35. Have you visited a doctor or other health care professional because of this neck pain **since we last questioned you**? No ☐ Yes ☐

36. **Since we last questioned you**, have you had to cut down or avoid any of the following activities in your job because of pain in the neck?

(Please tick one box for each line.)

	Not needed to cut down/avoid this activity	*Had to cut down/avoid because of back pain*	*This activity is not normally part of the job*
a) Lifting loads greater than 10 kg (20lbs).	☐	☐	☐
b) Working with your hands above shoulder height.	☐	☐	☐
c) Working as a professional driver (ie driving in the job for an hour or more on most work days).	☐	☐	☐

37. Have you had this neck pain during the **past 4 weeks**? *If **NO**, go to question 39.* No ☐ Yes ☐

38. If you had neck pain, how would you rate it on a 0 - 10 scale during a typical day in the **past 7 days** (where **0 = no pain** and **10 = worst pain you can imagine**)?

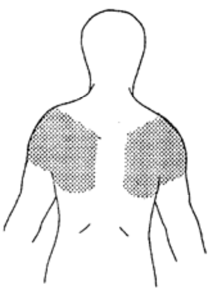
(Please circle one number.)

No pain — *Worst pain you can imagine*

0 1 2 3 4 5 6 7 8 9 10

Finally, in this section, some questions about pain in your SHOULDER(S)

39. Since answering our questionnaire approximately 12 months ago, have you had **shoulder pain** (in the area shown in the diagram), which lasted more than a day?



No ☐ Yes ☐

*If **NO**, go straight to question 45, page 12.*

39a. If ***YES*** how long in total **since we last questioned you** has this shoulder pain been present? *(Tick one.)*

1 - 2 days ☐ 3 - 6 days ☐ 7 - 30 days ☐
1 - 3 months ☐ More than 3 months ☐

40. How much time in total have you taken off work **since we last questioned you**, because of shoulder pain?

None ☐ 1 - 6 days ☐ 7 - 14 days ☐
15 - 30 days ☐ 1 - 3 months ☐ More than 3 months ☐

41. Have you visited a doctor or other health care professional because of this shoulder pain **since we last questioned you**? No ☐ Yes ☐

42. **Since we last questioned you**, have you had to cut down or avoid any of the following activities in your job because of pain in your shoulder(s)?

(Please tick one box for each line.)

	Not needed to cut down/avoid this activity	*Had to cut down/avoid because of back pain*	*This activity is not normally part of the job*
a) Lifting loads greater than 10 kg (20lbs).	☐	☐	☐
b) Digging or shovelling.	☐	☐	☐
c) Working with your hands above shoulder height.	☐	☐	☐
d) Working as a professional driver (ie driving in the job for an hour or more on most work days).	☐	☐	☐

43. Have you had this shoulder pain during the **past 4 weeks**? No ☐ Yes ☐

*If **NO**, go to question 45.*

44. If you had **shoulder** pain, how would you rate it on a 0 - 10 scale during a typical day in the **past 7 days** (where **0 = no pain** and **10 = worst pain you can imagine**)?

(Please circle one number.)

No pain — *Worst pain you can imagine*

0 1 2 3 4 5 6 7 8 9 10

SECTION E: OTHER SYMPTOMS AND FEELINGS

*This section concerns **other symptoms** and your **feelings** about health problems.*

45. Firstly, some questions about how you feel and how things have been with you **during the past 4 weeks**. *Please tick the <u>one box</u> for each question which most closely reflects how you feel.*

How much of the time **during the past 4 weeks** …….	*None of the time*	*A little of the time*	*Some of the time*	*Most of the time*	*All of the time*
a) …did you feel full of life?	☐	☐	☐	☐	☐
b) …have you been a very nervous person?	☐	☐	☐	☐	☐
c) …have you felt so down in the dumps that nothing could cheer you up?	☐	☐	☐	☐	☐
d) …have you felt calm and peaceful?	☐	☐	☐	☐	☐
e) …did you have a lot of energy?	☐	☐	☐	☐	☐
f) …have you felt downhearted and low?	☐	☐	☐	☐	☐
g) …did you feel worn out?	☐	☐	☐	☐	☐
h) …have you been a happy person?	☐	☐	☐	☐	☐
i) …did you feel tired?	☐	☐	☐	☐	☐

46. During the past **12 months**, how many days of sick leave have you taken (for all reasons combined)?

None ☐ 1 - 2 days ☐ 3 - 6 days ☐

7 - 30 days ☐ 1 - 3 months ☐ More than 3 months ☐

47. Below is a list of problems people sometimes have. Please read each one carefully and circle the number that best describes how much that problem has distressed or bothered **you** during the **past 7 days including today**.

		Not at all	*A little bit*	*Moderately*	*Quite a bit*	*Extremely*
a)	Faintness or dizziness.	0	1	2	3	4
b)	Pains in the heart or chest.	0	1	2	3	4
c)	Your feelings being easily hurt.	0	1	2	3	4
d)	Feeling that people are unfriendly or dislike you.	0	1	2	3	4
e)	Feeling inferior to others.	0	1	2	3	4
f)	Nausea or upset stomach.	0	1	2	3	4
g)	Trouble getting your breath.	0	1	2	3	4
h)	Numbness or tingling in parts of your body.	0	1	2	3	4
i)	Feeling weak in parts of your body.	0	1	2	3	4
j)	Feeling very self-conscious with others.	0	1	2	3	4

48. Whether you have back pain or not, based on your own views and what the doctor or others may have told you about pain in the back, how strongly do you agree with the following statements?

Please circle one number for each statement which most closely reflects how you feel.
1 means you completely disagree, 5 means you completely agree

		Completely disagree				*Completely agree*
a)	Physical activity worsens back pain	1	2	3	4	5
b)	Physical activities should be avoided if they might make the pain worse.	1	2	3	4	5
c)	An increase in pain is an indication to stop what one is doing.	1	2	3	4	5
d)	Rest is needed to get better.	1	2	3	4	5
e)	Normal work should be avoided until the pain is treated.	1	2	3	4	5
f)	It is important to see a doctor straight away at the first sign of trouble.	1	2	3	4	5
g)	Neglecting problems of this kind can cause permanent health problems.	1	2	3	4	5
h)	Back pain normally gets better by itself.	1	2	3	4	5

A part of our health survey is direct observation of the working environment and postures held while driving.

If you wish to participate in this study, a measuring system (which will not interfere with your driving and working tasks) will be installed in your car at the beginning of a working day and uninstalled at the end of the day.

As a 'thank you' for your cooperation you will be paid if you are selected to participate in this further study.

NO, I do not wish to participate in the study ☐

YES, I wish to participate in the study ☐

If *YES*, please give your phone number or contact (email address, etc.) to arrange the study. ____________________

If you have any questions concerning this study please contact Lenka Justinova, who is based at the University of Southampton (Email: lj1@isvr.soton.ac.uk, tel.: 02380 593235)

You have finished. Please take a moment to look through your answers. Return the questionnaire to us in the pre-paid envelope supplied.

APPENDIX B

Table B1. Individual information of taxi drivers, police drivers, pooled group of all drivers and police non-drivers (cross-sectional study).

Factors	Taxi drivers	Police drivers	Non-drivers	All drivers
	N (%)	N (%)	N (%)	N (%)
Age(yr)				
≤36	25 (12)	171 (47)	162 (33)	196 (34)
37-46	57 (27)	132 (36)	156 (32)	189 (33)
>46	126 (60)	61 (17)	161 (33)	187 (33)
Gender				
male	199 (95)	280 (77)	200 (41)	479 (83)
female	10 (5)	84 (23)	283 (58)	94 (16)
Height(cm)				
≤170.18	56 (27)	67 (18)	256 (53)	123 (23)
170.19-177.8	76 (36)	116 (32)	110 (23)	192 (36)
>177.8	40 (19)	181 (50)	113 (23)	221 (37)
missing	37 (18)		6 (1)	38 (4)
Weight(kg)				
≤73	371 (18)	97 (27)	213 (44)	134 (23)
74-86	75 (36)	129 (35)	128 (26)	204 (36)
>86	84 (40)	127 (35)	124 (26)	211 (37)
missing	13 (6)	12 (3)	20 (4)	25 (4)
BMI				
≤24.34	29 (14)	127 (35)	274 (36)	156 (27)
24.35-27.28	55 (26)	129 (35)	140 (29)	185 (32)
>27.28	81 (39)	96 (26)	150 (31)	177 (31)
missing	43 (21)	13 (4)	21 (4)	56 (10)
Smoking status				
ex-smoker/smoker	127 (61)	108 (30)	166 (34)	235 (41)
smoker	57 (27)	38 (10)	57 (12)	95 (17)
non-smoker	80 (38)	256 (70)	317 (65)	336 (59)
Physical activity				
never	123 (59)	81 (22)	152 (30)	204 (35)
1-2/week	40 (19)	136 (37)	143 (30)	176 (31)
3/week	28 (13)	77 (21)	80 (17)	105 (18)
>4/week	18 (9)	71 (20)	110 (23)	89 (16)

Table B2. Physical activities and driving information of taxi drivers, police drivers, pooled group of all drivers and non-drivers at work (cross-sectional study).

Factors	Taxi drivers	Police drivers	Non-drivers	All drivers
	N (%)	N (%)	N (%)	N (%)
Duration of work ≥10 years	107 (51)	186 (49)	156 (32)	293 (51)
Duration of work ≥40hours/week	154 (74)	303 (83)	181 (37)	457 (80)
Lifting at work (per day) not at all	32 (15)	146 (40)	350 (72)	178 (31)
1-10 times	156 (75)	206 (56)	129 (27)	362 (63)
>10 times	21 (10)	12 (3)	6 (1)	33 (6)
Lifting & bending at work (per day)				
not at all	70 (33)	243 (66)	428 (88)	313 (55)
1-10 times	121 (58)	121 (33)	50 (10)	242 (42)
>10 times	18 (9)	1 (0.5)	2 (0.5)	19 (3)
Lifting & twisting at work (per day)				
not at all	107 (51)	266 (73)	444 (92)	373 (65)
1-10 times	95 (46)	87 (24)	32 (7)	182 (32)
>10 times	7 (3)	2 (1)	0 (0)	9 (2)
Lifting & twisting &bending at work (per day) not at all	119 (56)	276 (76)	450 (93)	395 (69)
1-10 times	85 (41)	75 (21)	26 (5)	160 (28)
>10 times	5 (2)	4 (1)	0 (0.5)	9 (2)
Standing or walking (per day)				
none	17 (8)	0 (0)	40 (8)	17 (3)
<1 hour	98 (47)	59 (16)	208 (43)	157 (27)
1-3 hours	84 (40)	211 (58)	153 (32)	295 (51)
>3 hours	10 (5)	93 (26)	82 (17)	103 (18)
Trunk bent at work (per day)				
not at all	156 (75)	245 (67)	396 (82)	401 (70)
<5 times	20 (10)	50 (14)	36 (7)	70 (12)
5-20 times	26 (12)	53 (15)	40 (8)	79 (14)
>20 times	7 (3)	11 (3)	8 (2)	18 (3)
Trunk twisted at work (per day)				
not at all	161 (77)	285 (78)	437 (90)	446 (78)
<5 times	14 (7)	44 (12)	16 (3)	58 (10)
5-20 times	26 (12)	24 (7)	22 (5)	50 (9)
>20 times	7 (3)	6 (2)	7 (1)	13 (2)
Sitting other than driving (per day)				
<1 hour	22 (11)	29 (8)	36 (7)	51 (9)
1-3 hours	99 (47)	211 (58)	80 (17)	310 (54)
>3 hours	88 (42)	125 (34)	369 (76)	213 (37)
Previous job with professional driving	75 (36)	152 (42)	148 (31)	227 (40)
Previous job with heavy physical load	142 (68)	177 (49)	146 (30)	319 (56)
Previous job with prolonged sitting	84 (40)	122 (33)	234 (48)	206 (36)
Type of driven vehicle				
purpose build taxi	13 (8)			13 (2)
purpose adapted taxi	10 (3)			10 (2)
saloon car	187 (88)			187 (33)
other	2 (1)	13 (4)		15 (3)
traffic vehicle		47 (13)		47 (8)
squad car		286 (78)		286 (49)
traffic vehicle and squad car		17 (5)		17 (3)
Unloading vehicle	100 (48)	81 (22)		181 (32)
Driving off road (per day) not at all	148 (71)	261 (72)		409 (71)
<1 hour	34 (16)	84 (23)		118 (21)
1-3 hours	13 (6)	14 (4)		27 (5)
>3 hours	10 (5)	5 (1)		15 (3)

Table B3. Psychosocial status of taxi drivers, police drivers, pooled group of all drivers and police non-drivers at work (cross-sectional study).

Factors	Taxi drivers	Police drivers	All drivers	Non-drivers
	N (%)	N (%)	N (%)	N (%)
Job decision:				
(i) how to do your work:				
often	164 (79)	135 (37)	299 (52)	209 (43)
sometimes	18 (9)	161 (44)	179 (31)	154 (32)
seldom	8 (4)	48 (13)	56 (10)	68 (14)
never/almost never	15 (7)	21 (6)	36 (6)	52 (11)
(ii) what to do at work:				
often	139 (67)	88 (24)	227 (40)	137 (28)
sometimes	34 (16)	162 (44)	196 (34)	174 (36)
seldom	11 (5)	72 (20)	83 (15)	93 (19)
never/almost never	20 (10)	41 (11)	61 (11)	80 (17)
(iii) timetable & breaks:				
often	193 (92)	107 (29)	300 (52)	225 (46)
sometimes	11 (5)	124 (34)	135 (24)	139 (29)
seldom	1 (1)	70 (19)	71 (12)	59 (12)
never/almost never	2 (1)	61 (17)	63 (11)	60 (12)
Job support:				
often	28 (13)	172 (47)	200 (35)	261 (53)
sometimes	60 (29)	148 (40)	208 (36)	160 (33)
seldom	21 (10)	36 (10)	57 (10)	47 (10)
never	29 (14)	7 (2)	36 (6)	3 (1)
not applicable	69 (33)	2 (1)	71 (12)	13 (3)
Job satisfaction:				
very satisfied	56 (27)	83 (23)	139(24)	148 (31)
satisfied	135 (64)	236 (65)	371 (65)	279 (58)
dissatisfied	14 (7)	42 (12)	56 (10)	50 (10)
very dissatisfied	4 (2)	4(1)	8 (1)	7 (1)
Mental health status				
healthy	55 (26)	93 (26)	148 (26)	103 (21)
medium	69 (33)	146 (40)	215 (38)	205 (42)
poor	80 (38)	124 (34)	204 (36)	175 (36)
Energy and vitality status				
healthy	37 (18)	92 (25)	129 (23)	119 (25)
medium	72 (34)	133 (36)	205 (36)	168 (35)
poor	96 (46)	136 (37)	222 (39)	195 (40)
Psychosomatic distress status				
healthy	77 (37)	172 (47)	249 (43)	192 (40)
medium	54 (26)	107 (29)	161 (28)	153 (32)
poor	72 (34)	84 (23)	156 (27)	136(28)

Table B4. 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, and physical activity

	Study populations			
	Taxi drivers (n=209)	Police drivers (n=365)	Non-drivers (n=485)	All drivers (n=574)
Age (yr)	49.5 (10.5)	37.9 (8.4)	41.7 (10.5)	42.1 (10.8)
Height (cm)	174.6 (7.5)	178.3 (7.5)	170.9 (10.2)	177.11 (8.9)
Weight (kg)	87 (16.2)	81.5 (13)	77.1 (16.4)	83.5 (14.5)
Body mass index (kg/m^2)	28.3 (4.7)	25.6 (3.2)	26.1 (4.6)	26.5 (3.9)
Smoking (n):				
non-smokers	80 (38)	256 (70)	317 (65)	336 (59)
ex-smokers/smokers	127 (61)	108 (30)	166 (34)	235 (41)
current smokers	57 (27)	38 (10)	57 (12)	95 (17)
Physical activity (n):				
never	123 (59)	81(22)	152 (30)	204 (35)
1-2 per week	40 (19)	136 (37)	143 (30)	176 (31)
3-4 per week	28 (13)	77 (21)	80 (17)	105 (18)
> 4 per week	18 (9)	71 (20)	110 (23)	89 (16)

<u>Population of taxi drivers, police drivers and non-drivers:</u>

F test (one-way ANOVA): p<0.01 (except: BMI between police drivers and non-drivers)

Chi-square test: p<0.01 for all population

<u>Population of pooled group of all drivers and non-drivers:</u>

F test (one-way ANOVA): p<0.01 (except: age)

Chi-square test: p<0.01 (smoking), p<0.05 (physical activity)

Table B5a. Prevalence (cross-sectional study) of health symptoms in the total sample of taxi drivers (n=209), police drivers (n=365), pooled group of drivers (n=574) and non-drivers (n=485).

Outcome	Taxi drivers (%)	Police drivers (%)	All drivers (%)	Non-drivers (%)
LBP in the previous 12 months	45	53	50	46
LBP in the previous 4 weeks	29	35	33	21
LBP in the previous 7 days	11	19	19	11
Episodes of acute LBP in the previous 12 months	28	33	31	31
Episodes of sciatica in the previous 12 months	14	13	13	13
Duration of LBP > 30 d/yr in the previous 12 months	16	21	19	13
High pain intensity in the lower back in the previous 7 days (Von Korf pain scale score > 5)	7	4	5	3
Disability due to the last episode of LBP (Roland & Morris disability scale score ≥ 12)	5	4	4	2
Visit to a doctor for LBP in the previous 12 months	12	12	12	11
Sick leave > 7 days due to LBP in the previous 12 months	8	3	5	2
NP in the previous 12 months	33	30	31	35
NP in the previous 4 weeks	21	17	18	18
NP in the previous 7 days	13	10	11	9
SP in the previous 12 months	28	29	29	26
SP in the previous 4 weeks	15	17	16	14
SP in the previous 7 days	12	8	10	7

Table B5b. Incidence of health symptoms in the total sample of taxi drivers (n=144), police drivers (n=219), pooled group of drivers (n=300) and non-drivers (n=363).

Outcome	Taxi drivers (%)	Police drivers (%)	All drivers (%)	Non-drivers (%)
LBP in the previous 12 months	11	26	19	27
LBP in the previous 4 weeks	3	11	7	9
LBP in the previous 7 days	3	5	4	4
Episodes of acute LBP in the previous 12 months	10	21	16	21
Episodes of sciatica in the previous 12 months	1	2	2	4
Duration of LBP > 30 d/yr in the previous 12 months	1	5	3	4
High pain intensity in the lower back in the previous 7 days (Von Korf pain scale score > 5)	0	0	0	1
Disability due to the last episode of LBP (Roland & Morris disability scale score ≥ 12)	3	1	2	1
Visit to a doctor for LBP in the previous 12 months	3	2	2	6
Sick leave > 7 days due to LBP in the previous 12 months	1	0	1	1
NP in the previous 12 months	16	16	16	25
NP in the previous 4 weeks	11	9	10	15
NP in the previous 7 days	10	5	7	11
SP in the previous 12 months	14	24	19	19
SP in the previous 4 weeks	10	10	10	9
SP in the previous 7 days	10	4	7	8

Table B5c. Persistence of health symptoms in the total sample of taxi drivers (n=144), police drivers (n=219), pooled group of drivers (n=300) and non-drivers (n=363).

Outcome	Taxi drivers (%)	Police drivers (%)	All drivers (%)	Non-drivers (%)
LBP in the previous 12 months	67	77	74	63
LBP in the previous 4 weeks	41	54	49	36
LBP in the previous 7 days	41	31	34	19
Episodes of acute LBP in the previous 12 months	41	46	44	44
Episodes of sciatica in the previous 12 months	16	22	20	17
Duration of LBP > 30 d/yr in the previous 12 months	25	32	29	19
High pain intensity in the lower back in the previous 7 days (Von Korf pain scale score > 5)	13	8	10	3
Disability due to the last episode of LBP (Roland & Morris disability scale score ≥ 12)	9	6	7	4
Visit to a doctor for LBP in the previous 12 months	22	19	20	18
Sick leave > 7 days due to LBP in the previous 12 months	11	6	17	4
NP in the previous 12 months	41	48	45	38
NP in the previous 4 weeks	28	29	29	21
NP in the previous 7 days	28	16	20	13
SP in the previous 12 months	34	31	32	31
SP in the previous 4 weeks	28	17	21	19
SP in the previous 7 days	28	11	17	12

Table 6a. Binary logistic regression for the association between low back pain during past 12-months and various individual and work-related risk factors in taxi drivers, police drivers, poled group of drivers and non-drivers. In the table are presented crude odds ratios (OR) and 95% confidence intervals (95% CI). Cross-sectional study.

Factors		Taxi drivers (n=209)	Police drivers (n=365)	Drivers (n=574)	Non-drivers (n=485)
		OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Age (years)	≤36	1.0 (-)	1.0 (-)	1.0 (-)	1.0 (-)
	37-46	1.02 (0.39-2.65)	2 (1.26-3.18)	1.57 (1.05-2.34)	1.53 (0.98-2.4)
	>46	1.41 (0.59-3.37)	1.64 (0.91-2.97)	1.32 (0.88-1.98)	1.86 (1.19-2.89)
BMI (kg/m^2)	≤24.34	1.0 (-)	1.0 (-)	1.0 (-)	1.0 (-)
	24.35-27.28	0.76 (0.31-1.89)	1.1 (0.67-1.8)	0.99 (0.65-1.52)	1.22 (0.78-1.92)
	>27.29	1.04 (0.44-2.43)	2.42 (1.39-4.2)	1.59 (1.03-2.45)	1.49 (0.96-2.31)
	missing	1.29 (0.5-3.32)	1.84 (0.57-5.95)	1.35 (0.73-2.48)	1.32 (0.53-3.27)
Height (cm)	≤170.18	1.0 (-)	1.0 (-)	1.0 (-)	1.0 (-)
	170.19-177.8	3.09 (1.48-6.44)	1.14 (0.63-2.09)	1.75 (1.1-2.77)	1.61 (1.02-2.52)
	>177.8	1.85 (0.79-4.34)	1.3 (0.74-2.28)	1.73 (1.11-2.71)	2.43 (1.54-3.82)
	missing	2.64 (1.11-6.28)		1.51 (0.73-3.14)	
Weight (kg)	≤73	1.0 (-)	1.0 (-)	1.0 (-)	1.0 (-)
	74-86	1.96 (0.85-4.54)	1.06 (0.62-1.8)	1.24 (0.8-1.93)	1.68 (1.08-2.62)
	>87	2.6 (1.14-5.93)	2.54 (1.47-4.38)	2.33 (1.5-3.63)	1.98 (1.26-3.1)
	missing	1.48 (0.39-5.54)		1.61 (0.68-3.78)	0.88 (0.34-2.29)
Smoking status					
	no smoking	1.0 (-)	1.0 (-)	1.0 (-)	1.0 (-)
	smoker/ex-smoker	1.73 (0.98-3.07)	1.08 (0.69-1.7)	1.13 (0.81-1.58)	1.16 (0.8-1.69)
Regular practising of sport					
	no	1.0 (-)	1.0 (-)	1.0 (-)	1.0 (-)
	yes	1.2 (0.69-2.07)	1.44 (0.83-2.53)	1.24 (0.87-1.78)	0.99 (0.66-1.48)
Duration of work:					
≥ 10 years	no	1.0 (-)	1.0 (-)	1.0 (-)	1.0 (-)
	yes	1.23 (0.71-2.12)	1.39 (0.92-2.09)	1.32 (0.95-1.84)	1.42 (0.97-2.09)
≥40 hrs/week	no	1.0 (-)	1.0 (-)	1.0 (-)	1.0 (-)
	yes	1.85 (0.96-3.54)	1.05 (0.6-1.84)	1.4 (0.92-2.12)	1.62 (1.12-2.35)
Lifting at work	no	1.0 (-)	1.0 (-)	1.0 (-)	1.0 (-)
	yes	2.84 (1.21-6.65)	1.84 (1.21-2.81)	1.74 (1.21-2.48)	0.9 (0.6-1.34)
Lifting while bending at work	no	1.0 (-)	1.0 (-)	1.0 (-)	1.0 (-)
	yes	2.35 (1.28-4.29)	2.06 (1.31-3.22)	1.77 (1.27-2.46)	1.23 (0.69-2.19)
Lifting while twisting at work					
	no	1.0 (-)	1.0 (-)	1.0 (-)	1.0 (-)
	yes	1.82 (1.05-3.16)	2.03 (1.23-3.35)	1.64 (1.17-2.29)	1.78 (0.86-3.7)
Lifting while bending and twisting at work	no	1.0 (-)	1.0 (-)	1.0 (-)	1.0 (-)
	yes	1.97 (1.13-3.43)	2.39 (1.4-4.08)	1.83 (1.29-2.61)	1.64 (0.74-3.66)
Standing or walking (≥1hr/day)	no	1.0 (-)	1.0 (-)	1.0 (-)	1.0 (-)
	yes	1.24 (0.72-2.14)	0.88 (0.5-1.53)	1.19 (0.83-1.7)	0.85 (0.59-1.21)
Trunk bent at work	no	1.0 (-)	1.0 (-)	1.0 (-)	1.0 (-)
	yes	1.13 (0.6-2.1)	2.08 (1.32-3.28)	1.73 (1.2-2.48)	1.7 (1.06-2.71)
Trunk twisted at work	no	1.0 (-)	1.0 (-)	1.0 (-)	1.0 (-)
	yes	1.71 (0.89-3.29)	1.51 (0.91-2.5)	1.57 (1.05-2.34)	1.11 (0.61-2.02)
Sitting > 3h at work	no	1.0 (-)	1.0 (-)	1.0 (-)	1.0 (-)
	yes	1.42 (0.82-2.47)	1.06 (0.69-1.64)	1.15 (0.82-1.62)	0.88 (0.55-1.39)
Previous job with:					
Professional driving		1.43 (0.81-2.53)	1.3 (0.86-1.98)	1.37 (0.98-1.91)	1.02 (0.69-1.51)
Physical demands		2.1 (1.15-3.86)	1.36 (0.9-2.06)	1.44 (1.04-2.02)	0.95 (0.65-1.41)
Sitting		1.2 (0.69-2.08)	1.21 (0.78-1.87)	1.18 (0.83-1.65)	0.92 (0.64-1.31)

Table 6b. Binary logistic regression for the association between low back pain during past 12-months and various individual and work-related risk factors in taxi drivers. In the table are presented crude odds ratios (OR) and 95% confidence intervals (95% CI).

Factors	Taxi drivers (n=209)	Police drivers (n=365)	Drivers (n=574)	Non-drivers (n=485)
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
No choice and decision at work:				
how to work				
yes	1.0 (-)	1.0 (-)	1.0 (-)	1.0 (-)
no	1.36 (0.57-3.24)	1.09 (0.64-1.84)	1.2 (0.77-1.88)	1.15 (0.76-1.74)
what to do at work				
yes	1.0 (-)	1.0 (-)	1.0 (-)	1.0 (-)
no	1.14 (0.53-2.46)	0.85 (0.55-1.33)	0.98 (0.67-1.43)	0.94 (0.65-1.37)
timetables and breaks				
yes	1.0 (-)	1.0 (-)	1.0 (-)	1.0 (-)
no	0.06 (0.05-6.69)	0.96 (0.63-1.48)	1.1 (0.75-1.62)	0.92 (0.6-1.39)
Support from colleagues				
yes	1.0 (-)	1.0 (-)	1.0 (-)	1.0 (-)
low support	1.17 (0.58-2.36)	2.17 (1.09-4.31)	1.35 (0.86-2.13)	1.41 (0.79-2.55)
not applicable	1.26 (0.67-2.38)		0.89 (0.53-1.47)	
Satisfaction at job				
yes	1.0 (-)	1.0 (-)	1.0 (-)	1.0 (-)
no	0.98 (0.37-2.58)	2.19 (1.13-4.26)	1.75 (1.02-2.98)	1.5 (0.86-2.62)
Mental health status				
healthy	1.0 (-)	1.0 (-)	1.0 (-)	1.0 (-)
medium	1.04 (0.5-2.16)	0.7 (0.41-1.18)	0.84 (0.55-1.28)	0.77 (0.48-1.23)
poor	1.98 (0.98-3.99)	1.26 (0.73-2.17)	1.5 (0.98-2.29)	1.0 (0.62-1.63)
Energy and vitality status				
healthy	1.0 (-)	1.0 (-)	1.0 (-)	1.0 (-)
medium	3.48 (1.29-9.41)	1.16 (0.68-1.98)	1.4 (0.89-2.19)	0.92 (0.57-1.48)
poor	7.55 (2.88-19.81)	1.36 (0.8-3.2)	2.06 (1.33-3.2)	1.33 (0.84-2.1)
Psychosomatic distress status				
healthy	1.0 (-)	1.0 (-)	1.0 (-)	1.0 (-)
medium	4.45 (2.05-9.68)	1.64 (1.01-2.66)	2.11 (1.41-3.16)	1.39 (0.9-2.13)
poor	7.77 (3.69-16.35)	2.47 (1.43-4.25)	3.32 (2.18-5.05)	1.86 (1.19-2.91)

Table 7a. Measures of daily exposure to whole-body vibration (WBV) in the professional drivers at the cross-sectional survey. Data are given as means (standard deviations).

Measures of daily vibration exposure	Driver groups		
	Taxi drivers (n=209)	Police drivers (n=365)	All drivers (n=574)
Daily driving time (h)	7.9 (3.03)	2.92 (1.62)	4.74 (3.28)
$A_v(8)$ (ms^{-2} r.m.s.)	0.5 (0.1)	0.32 (0.09)	0.39 (0.13)
$A_{dom}(8)$ (ms^{-2} r.m.s.)	0.43 (0.17)	0.26 (0.07)	0.32 (0.14)
VDV_v ($ms^{-1.75}$)	9.27 (1.0)	7.16 (1.01)	7.92 (1.44)
VDV_{dom} ($ms^{-1.75}$)	8.34 (0.98)	6.09 (0.86)	6.92 (1.41)

Population of taxi drivers, police drivers:
Kruskall-Wallis one-way analysis of variance: $p<0.001$

Table 7b. Measures of cumulative (lifetime) exposure to whole-body vibration (WBV) in the professional drivers at the cross-sectional survey. For calculation of cumulative exposure to whole-body vibration was used 40 weeks in one working year. Data are given as means (standard deviations).

Measures of cumulative WBV exposure	Driver groups		
	Taxi drivers (n=209)	Police drivers (n=365)	All drivers (n=574)
Duration of exposure (yr)	12.27 (9.97)	11.34 (8.23)	11.68 (8.91)
$\sum[t_i]$ (h $\times 10^3$)	54.92 (13.48)	39.35 (10.65)	46.24 (15.38)
$\sum[a_{wsi} t_i]$ (ms^{-2}h $\times 10^3$)	21.39 (39.49)	6.61 (6.44)	11.9 (25.17)
$\sum[a_{wsi}^2 t_i]$ (m^{2}s^{-4}h $\times 10^3$)	11.09 (20.38)	3.59 (3.39)	6.35 (13.14)
$\sum[a_{wsi}^4 t_i]$ (m^{4}s^{-8}h $\times 10^3$)	5.7 (10.51)	1.97 (1.88)	3.34 (6.78)
$\sum[a_{wqi} t_i]$ (ms^{-2}h $\times 10^3$)	1.5 (2.8)	0.6 (0.58)	0.93 (1.81)
$\sum[a_{wq}{}^2{}_i t_i]$ (m^{2}s^{-4}h $\times 10^3$)	17.16 (31.59)	4.16 (3.93)	8.94 (20.36)
$\sum[a_{wqi}^4 t_i]$ (m^{4}s^{-8}h $\times 10^3$)	13.63 (25.27)	2.66 (2.52)	6.69 (16.31)
$VDV_{Total\text{-dom}}$ (ms$^{-1.75}$)	54.92 (13.79)	39.35 (10.65)	11.9 (25.17)

<u>Population of taxi drivers, police drivers:</u>
Kruskall-Wallis one-way analysis of variance: p<0.001 (except duration of exposure in years)

Table 8a. Univariate logistic regression of low back pain in the 12-months on alternative measures of daily exposure to whole-body vibration (WBV) in the taxi drivers, police drivers and pooled group of drivers in the cross-sectional study. Each measure of WBV exposure was included as a third based design variable, assuming the lowest quartile as the reference category. In the table are presented crude odds ratios (OR) and 95% confidence intervals (95% CI).

Measures of daily WBV exposure	Taxi drivers (n=209)			Police drivers (n=365)			All drivers (n=574)		
	Q1	Q2	Q3	Q1	Q2	Q3	Q1	Q2	Q3
Daily driving time (h)									
OR	1.0	0.91	2.3	1.0	1.27	1.06	1.0	0.84	0.79
(95% CI)	(-)	(0.56-2.14)	(1.17-4.52)	(-)	(0.74-2.18)	(0.66-1.7)	(-)	(0.55-1.27)	(0.54-1.16)
$A_v(8)$ (ms^{-2} r.m.s.)									
OR	1.0	1.18	2.55	1.0	1.4	1.07	1.0	1.01	1.02
(95% CI)	(-)	(0.59-2.36)	(1.27-5.12)	(-)	(0.82-2.4)	(0.66-1.74)	(-)	(0.68-1.51)	(0.67-1.55)
$A_{dom}(8)$ (ms^{-2} r.m.s.)									
OR	1.0	1.42	2.68	1.0	1.4	1.07	1.0	1.03	1.16
(95% CI)	(-)	(0.72-2.82)	(1.34-5.4)	(-)	(0.82-2.4)	(0.66-1.74)	(-)	(0.69-1.53)	(0.76-1.76)
VDV_v ($ms^{-1.75}$)									
OR	1.0	1.37	2.68	1.0	1.27	1.06	1.0	1	0.86
(95% CI)	(-)	(0.69-2.73)	(1.34-5.4)	(-)	(0.74-2.18)	(0.66-1.7)	(-)	(0.67-1.5)	(0.58-1.29)
VDV_{dom} ($ms^{-1.75}$)									
OR	1.0	1.09	2.1	1.0	1.36	1.07	1.0	0.93	0.82
(95% CI)	(-)	(0.46-1.81)	(1.06-4.16)	(-)	(0.8-2.33)	(0.66-1.74)	(-)	(0.61-1.42)	(0.56-1.2)

Table 8b. Univariate logistic regression of low back pain in the 12-months on alternative measures of cumulative vibration exposure to whole-body vibration (WBV) in the taxi drivers, police drivers and pooled group of drivers in the cross-sectional study. Each measure of WBV exposure was included as a third based design variable, assuming the lowest quartile as the reference category. In the table are presented crude odds ratios (OR) and 95% confidence intervals (95% CI).

Measures of daily WBV exposure		Taxi drivers (n=209)			Police drivers (n=365)			All drivers (n=574)		
		Q1	Q2	Q3	Q1	Q2	Q3	Q1	Q2	Q3
Exposure duration (yr)	OR	1.0	0.91	1.32	1.0	1.2	1.92	1.0	1.06	1.71
	(95% CI)	(-)	(0.47-1.76)	(0.68-2.59)	(-)	(0.72-1.98)	(0.15-3.2)	(-)	(0.71-1.58)	(1.14-2.55)
$\sum[t_i]$ (h $\times 10^3$)	OR	1.0	1.29	1.89	1.0	1.24	1.37	1.0	1.43	1.33
	(95% CI)	(-)	(0.65-2.56)	(0.94-3.77)	(-)	(0.75-2.05)	(0.83-2.27)	(-)	(0.96-2.14)	(0.89-2)
$\sum[a_{wsi}t_i]$($ms^{-2}h\times 10^3$)	OR	1.0	1.29	1.94	1.0	1.46	1.46	1.0	1.51	1.43
	(95% CI)	(-)	(0.65-2.56)	(0.97-3.87)	(-)	(0.87-2.44)	(0.87-2.44)	(-)	(1-2.27)	(0.95-2.16)
$\sum[a_{wsi}^2 t_i]$ ($m^2s^{-4}h \times 10^3$)	OR	1.0	1.33	1.89	1.0	1.36	1.56	1.0	1.46	1.48
	(95% CI)	(-)	(0.68-2.63)	(0.94-3.77)	(-)	(0.81-2.28)	(0.93-2.62)	(-)	(0.97-2.2)	(0.98-2.23)
$\sum[a_{wsi}^4 t_i]$ ($m^4s^{-8}h \times 10^3$)	OR	1.0	1.43	1.87	1.0	1.36	1.56	1.0	1.4	1.54
	(95% CI)	(-)	(0.72-2.84)	(0.94-3.7)	(-)	(0.81-2.28)	(0.93-2.62)	(-)	(0.93-2.11)	(1.02-2.33)
$\sum[a_{wqi}t_i]$ ($ms^{-2}h \times 10^3$)	OR	1.0	1.29	1.94	1.0	1.41	1.51	1.0	1.4	1.35
	(95% CI)	(-)	(0.65-2.56)	(0.97-3.87)	(-)	(0.84-2.36)	(0.9-2.53)	(-)	(0.93-2.11)	(0.9-2.04)
$\sum[a_{wqi}^2 t_i]$ ($m^2s^{-4}h \times 10^3$)	OR	1.0	1.54	1.94	1.0	1.46	1.46	1.0	1.44	1.31
	(95% CI)	(-)	(0.77-3.06)	(0.98-3.87)	(-)	(0.87-2.44)	(0.87-2.44)	(-)	(0.96-2.17)	(0.87-1.97)
$\sum[a_{wqi}^4 t_i]$ ($m^4s^{-8}h \times 10^3$)	OR	1.0	1.34	1.98	1.0	1.36	1.56	1.0	1.36	1.14
	(95% CI)	(-)	(0.67-2.68)	(1-3.92)	(-)	(0.81-2.28)	(0.93-2.62)	(-)	(0.91-2.06)	(0.76-1.71)
$VDV_{Total\text{-}dom}$ ($ms^{-1.75}$)	OR	1.0	1.57	2.05	1.0	1.4	1.51	1.0	1.27	1.37
	(95% CI)	(-)	(0.79-3.14)	(1.02-4.11)	(-)	(0.83-2.35)	(0.9-2.55)	(-)	(0.84-1.91)	(0.91-2.06)

Table 9. Standard multivariate logistic regression for the association between low back pain during past 12-months and various individual and work-related risk factors in taxi drivers, police drivers, poled group of drivers and non-drivers. In the table are presented adjusted odds ratios (OR) and 95% confidence intervals (95% CI). Cross-sectional study.

Factors		Taxi drivers (n=209)	Police drivers (n=365)	Drivers (n=574)	Non-drivers (n=485)
		OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Age (years)	≤36	1.0 (-)	1.0 (-)	1.0 (-)	1.0 (-)
	37-46	0.73 (0.25-2.13)	2.23 (1.34-3.69)	1.52 (0.96-2.42)	1.45 (0.88-2.39)
	>46	1.15 (0.43-3.03)	1.88 (0.98-3.62)	1.63 (0.96-2.75)	2.05 (1.24-3.39)
Gender					
	female				1.0 (-)
	male				0.74 (0.38-1.44)
Height (cm)	≤170.18	1.0 (-)	1.0 (-)	1.0 (-)	1.0 (-)
	170.19-177.8	2.67 (1.11-6.4)	0.98 (0.5-1.91)	1.15 (0.68-1.95)	1.6 (0.88-2.93)
	>177.8	1.33 (0.48-3.71)	1.12 (0.6-2.07)	0.87 (0.48-1.55)	2.78 (1.31-5.92)
Weight (kg)	≤73	1.0 (-)		1.0 (-)	1.0 (-)
	74-86	1.73 (0.64-4.7)		1.39 (0.81-2.39)	1.22 (0.7-2.11)
	>87	2.38 (0.87-6.52)		2.63 (1.47-4.71)	0.9 (0.49-1.64)
Duration of work:					
≥40 hrs/week	no				1.0 (-)
	yes				1.57 (0.99-2.51)
Lifting at work	no	1.0 (-)	1.0 (-)	1.0 (-)	
	yes	1.63 (0.61-4.35)	1.57 (0.99-2.49)	1.73 (1.13-2.64)	
Trunk bent at work	no		1.0 (-)	1.0 (-)	1.0 (-)
	yes		2.19 (1.33-3.62)	1.6 (1.04-2.45)	1.98 (1.18-3.29)
Trunk twisted at work					
	no			1.0 (-)	
	yes			1.09 (0.68-1.77)	
Previous job with:					
	Physical demands	2.01 (1.03-4.29)		1.33 (0.92-1.94)	
Support from colleagues					
	yes		1.0 (-)		
	low support		1.97 (0.95-4.1)		
Psychosomatic distress status					
	healthy	1.0 (-)	1.0 (-)	1.0 (-)	1.0 (-)
	medium	4.53 (1.97-10.41)	1.62 (0.97-2.72)	2.39 (1.55-3.69)	1.61 (1.01-2.56)
	poor	7.46 (3.38-16.49)	2.37 (1.33-4.22)	3.91 (2.47-6.19)	2.01 (1.23-3.28)
Type of occupation					
	taxi driver			1.0 (-)	
	police driver			2.97 (1.81-4.86)	

Table 10a. Multivariate logistic regression of low back pain in the 12-months on alternative measures of daily exposure to whole-body vibration (WBV) in the taxi drivers, police drivers and pooled group of drivers in the cross-sectional study. Each measure of WBV exposure was included as a third based design variable, assuming the lowest quartile as the reference category. In the table are presented adjusted odds ratios (OR) and 95% confidence intervals (95% CI).

Measures of daily WBV exposure	Taxi drivers (n=209)			Police drivers (n=365)			All drivers (n=574)		
	Q1	Q2	Q3	Q1	Q2	Q3	Q1	Q2	Q3
Daily driving time (h)									
OR	1.0	0.94	2.56	1.0	1.22	0.95	1.0	0.86	0.84
(95% CI)	(-)	(0.42-2.1)	(1.13-5.79)	(-)	(0.68-2.2)	(0.56-1.59)	(-)	(0.53-1.41)	(0.45-1.56)
$A_v(8)$ (ms^{-2} r.m.s.)									
OR	1.0	1.3	2.92	1.0	1.28	0.93	1.0	1.07	1.24
(95% CI)	(-)	(0.57-2.93)	(1.26-6.79)	(-)	(0.71-2.3)	(0.54-1.58)	(-)	(0.67-1.69)	(0.69-2.24)
$A_{dom}(8)$ (ms^{-2} r.m.s.)									
OR	1.0	1.77	3.5	1.0	1.28	0.93	1.0	1.64	1.47
(95% CI)	(-)	(0.78-4.01)	(1.5-8.2)	(-)	(0.71-2.3)	(0.54-1.58)	(-)	(0.66-1.63)	(0.85-2.57)
VDV_v ($ms^{-1.75}$)									
OR	1.0	1.63	3.47	1.0	1.18	0.97	1.0	1.04	1.04
(95% CI)	(-)	(0.71-3.74)	(1.47-8.17)	(-)	(0.66-2.13)	(0.57-1.64)	(-)	(0.65-1.65)	(0.56-1.93)
VDV_{dom} ($ms^{-1.75}$)									
OR	1.0	1.29	2.81	1.0	1.25	0.94	1.0	0.88	1.01
(95% CI)	(-)	(0.57-2.93)	(1.13-5.79)	(-)	(0.7-2.25)	(0.55-1.6)	(-)	(0.54-1.43)	(0.49-2.08)

Taxi drivers- OR adjusted for age, weight, height, lifting at work, lifting at previous job, psychosomatic distress
Police drivers- OR adjusted for age, weight, lifting at work, bending at work, support at work, psychosomatic distress
Pooled group of all drivers- OR adjusted for age, height, weight, type of occupation, lifting, twisting and bending at work, lifting at previous job, psychosomatic distress

Table 10b. Multivariate logistic regression of low back pain in the 12-months on alternative measures of cumulative vibration exposure to whole-body vibration (WBV) in the taxi drivers, police drivers and pooled group of drivers in the cross-sectional study. Each measure of WBV exposure was included as a third based design variable, assuming the lowest quartile as the reference category. In the table are presented adjusted odds ratios (OR) and 95% confidence intervals (95% CI).

Measures of daily WBV exposure		Taxi drivers (n=209)			Police drivers (n=365)			All drivers (n=574)		
		Q1	Q2	Q3	Q1	Q2	Q3	Q1	Q2	Q3
Exposure duration (yr)	OR (95% CI)	1.0 (-)	1.46 (0.64-3.35)	1.75 (0.71-4.35)	1.0 (-)	1.35 (0.78-2.34)	1.56 (0.82-2.96)	1.0 (-)	1.27 (0.81-1.99)	1.64 (1-2.71)
$\sum[t_i]$ (h $\times 10^3$)	OR (95% CI)	1.0 (-)	1.38 (0.59-3.24)	2.57 (1-6.62)	1.0 (-)	1.16 (0.67-2)	0.96 (0.54-1.71)	1.0 (-)	1.38 (0.87-2.19)	1.37 (0.82-2.31)
$\sum[a_{wsi}t_i]$($ms^{-2}h \times 10^3$)	OR (95% CI)	1.0 (-)	1.44 (0.62-3.36)	2.67 (1.05-6.79)	1.0 (-)	1.39 (0.8-2.42)	1 (0.56-1.8)	1.0 (-)	1.47 (0.92-2.34)	1.48 (0.88-2.49)
$\sum[a_{wsi}^2 t_i]$ ($m^2s^{-4}h \times 10^3$)	OR (95% CI)	1.0 (-)	1.48 (0.64-3.44)	2.62 (1.02-6.72)	1.0 (-)	1.31 (0.76-1.93)	1.08 (0.8-13.13)	1.0 (-)	1.41 (0.88-2.24)	1.51 (0.9-2.54)
$\sum[a_{wsi}^4 t_i]$ ($m^4s^{-8}h \times 10^3$)	OR (95% CI)	1.0 (-)	1.52 (0.66-3.53)	2.66 (1.06-6.72)	1.0 (-)	1.31 (0.76-1.93)	1.08 (0.8-13.13)	1.0 (-)	1.38 (0.87-2.2)	1.61 (0.96-2.7)
$\sum[a_{wqi}t_i]$ ($ms^{-2}h \times 10^3$)	OR (95% CI)	1.0 (-)	1.44 (0.62-3.36)	2.67 (1.05-6.79)	1.0 (-)	1.32 (0.46-2.29)	1.07 (0.6-13.13)	1.0 (-)	1.36 (0.85-2.17)	1.53 (0.88-2.63)
$\sum[a_{wqi}^2 t_i]$ ($m^2s^{-4}h \times 10^3$)	OR (95% CI)	1.0 (-)	1.83 (0.78-4.29)	2.92 (1.15-7.42)	1.0 (-)	1.39 (0.8-2.28)	1 (0.56-1.8)	1.0 (-)	1.44 (0.9-2.07)	1.58 (0.89-2.8)
$\sum[a_{wqi}^4 t_i]$ ($m^4s^{-8}h \times 10^3$)	OR (95% CI)	1.0 (-)	1.49 (0.64-3.46)	2.73 (1.09-6.86)	1.0 (-)	1.31 (0.8-2.28)	1.08 (0.6-1.93)	1.0 (-)	1.29 (0.8-2.07)	1.46 (0.76-2.81)
$VDV_{Total\text{-}dom}$ ($ms^{-1.75}$)	OR (95% CI)	1.0 (-)	1.89 (0.81-4.42)	3.13 (1.21-8.14)	1.0 (-)	1.29 (0.74-2.26)	1.02 (0.57-1.84)	1.0 (-)	1.19 (0.75-1.9)	1.51 (0.88-2.62)

Taxi drivers- OR adjusted for age, weight, height, lifting at work, lifting at previous job, psychosomatic distress
Police drivers- OR adjusted for age, weight, lifting at work, bending at work, support at work, psychosomatic distress
Pooled group of all drivers- OR adjusted for age, height, weight, type of occupation, lifting, twisting and bending at work, lifting at previous job, psychosomatic distress

Table 11. Stepwise multivariate logistic regression for the association between low back pain during past 12-months and various individual and work-related risk factors in taxi drivers, police drivers, poled group of drivers and non-drivers. In the table are presented adjusted odds ratios (OR) and 95% confidence intervals (95% CI). Cross-sectional study.

Factors		Taxi drivers (n=209)	Police drivers (n=365)	Drivers (n=574)	Non-drivers (n=485)
		OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Age (years)	≤36		1.0 (-)		
	37-46		2.31 (1.41-3.79)		
	>46		2.07 (1.1-3.9)		
Height (cm)	≤170.18	1.0 (-)			1.0 (-)
	170.19-177.8	3.23 (1.43-7.29)			1.64 (1.03-2.61)
	>177.8	1.86 (0.73-4.74)			2.71 (1.68-4.36)
Weight (kg)	≤73			1.0 (-)	
	74-86			1.53 (0.95-2.48)	
	>87			2.88 (1.78-4.67)	
Lifting at work	no		1.0 (-)	1.0 (-)	
	yes		1.66 (1.05-2.62)	1.7 (1.13-2.56)	
Trunk bent at work	no		1.0 (-)	1.0 (-)	1.0 (-)
	yes		2.16 (1.32-3.35)	1.6 (1.08-2.38)	1.85 (1.13-3.04)
Previous job with:					
	Physical demands	2.23 (1.12-4.45)			
Psychosomatic distress status					
	healthy	1.0 (-)	1.0 (-)	1.0 (-)	1.0 (-)
	medium	4.36 (1.94-9.79)	1.68 (1.01-2.81)	2.34 (1.53-3.59)	1.45 (0.92-2.28)
	poor	7.24 (3.35-15.63)	2.39 (1.35-4.24)	4.04 (2.56-6.36)	1.85 (1.16-2.96)
Type of occupation					
	taxi driver			1.0 (-)	
	police driver			2.15 (1.44-3.2)	

Table 12. 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).

Type of driven vehicle	Model of driven vehicle	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_{ws} (ms^{-2} r.m.s.)
Taxi					
Saloon car	Skoda Octavia	0.12	0.14	0.47	0.52
Purpose build vehicle	TX1	0.14	0.16	0.44	0.5
Purpose adapted vehicle	Vauxhall Zafira	0.17	0.13	0.39	0.47
Police vehicle					
General purpose vehicles					
	Land Rover-Discovery	0.16	0.22	0.36	0.48
	Vauxhall Astra	0.22	0.18	0.58	0.67
	Ford Focus	0.15	0.19	0.38	0.48
Traffic control vehicle					
	Vauxhall Omega	0.19	0.23	0.43	0.56
	BMW 750	0.14	0.24	0.45	0.56
	Ford Mondeo	0.2	0.22	0.46	0.58
Off-road vehicle					
	Land Rover-Ranger	0.19	0.22	0.43	0.55

Table 13. Persistence group of participants in the follow-up of the longitudinal study. Standard multivariate logistic regression for the association between low back pain during past 12-months and various individual and work-related risk factors in taxi drivers, police drivers, poled group of drivers and non-drivers. In the table are presented adjusted odds ratios (OR) and 95% confidence intervals (95% CI).

Factors		Taxi drivers (n=209)	Police drivers (n=365)	Drivers (n=574)	Non-drivers (n=485)
		OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Age (years)	≤36	1.0 (-)	1.0 (-)	1.0 (-)	1.0 (-)
	37-46	3.42 (0.3-38.57)	1.68 (0.61-4.61)	0.7 (0.29-1.71)	3.23 (1.16-8.98)
	>46	1.67 (0.2-14.0)	0.81 (0.26-2.56)	1.02 (0.35-2.99)	1.48 (0.59-3.76)
Height (cm)	≤170.18	1.0 (-)			1.0 (-)
	170.19-177.8	5.55 (1.12-27.43)			1.67 (0.67-4.18)
	>177.8	16.56 (1.8-152.4)			2.02 (0.8-5.11)
Weight (kg)	≤73			1.0 (-)	
	74-86			0.85 (0.27-2.64)	
	>87			0.72 (0.25-2.09)	
Lifting at work	no		1.0 (-)	1.0 (-)	
	yes		1.13 (0.45-2.85)	1.38 (0.59-3.22)	
Trunk bent at work	no		1.0 (-)	1.0 (-)	1.0 (-)
	yes		1.6 (0.61-4.16)	1.43 (0.67-3.06)	3.58 (1.17-10.95)
Previous job with:	Physical demands	0.88 (0.21-3.72)			
Psychosomatic distress status	healthy	1.0 (-)	1.0 (-)	1.0 (-)	1.0 (-)
	medium	1.72 (0.27-10.9)	1.65 (0.59-4.61)	1.55 (0.65-3.67)	1.83 (0.75-4.45)
	poor	6.2 (1.3-29.6)	4.76 (1.48-15.26)	5.27 (2.17-12.79)	1.81 (0.68-4.82)
Type of occupation	taxi driver			1.0 (-)	
	police driver			2.46 (0.99-6.12)	

Table 14. Incidence group of participants in the follow-up of the longitudinal study. Standard multivariate logistic regression for the association between low back pain during past 12-months and various individual and work-related risk factors in taxi drivers, police drivers, poled group of drivers and non-drivers. In the table are presented adjusted odds ratios (OR) and 95% confidence intervals (95% CI).

Factors		Taxi drivers (n=209)	Police drivers (n=365)	Drivers (n=574)	Non-drivers (n=485)
		OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Age (years)	≤36		1.0 (-)	1.0 (-)	1.0 (-)
	37-46		3.21 (1.11-9.25)	1.23 (0.46-3.34)	1.2 (0.49-2.97)
	>46		0.29 (0.03-2.65)	0.78 (0.27-2.27)	0.82 (0.32-2.14)
Height (cm)	≤170.18				1.0 (-)
	170.19-177.8				0.53 (0.2-1.42)
	>177.8				1.97 (0.73-5.37)
Weight (kg)	≤73			1.0 (-)	
	74-86			1.6 (0.53-4.84)	
	>87			2 (0.65-6.16)	
Lifting at work	no		1.0 (-)	1.0 (-)	
	yes		0.43 (0.14-1.38)	0.7 (0.27-1.79)	
Trunk bent at work	no		1.0 (-)	1.0 (-)	1.0 (-)
	yes		0.35 (0.06-2.07)	0.56 (0.18-1.71)	0.75 (0.26-2.2)
Previous job with:	Physical demands				
Psychosomatic distress status	healthy		1.0 (-)	1.0 (-)	1.0 (-)
	medium		1.53 (0.48-4.87)	2.17 (0.83-5.71)	0.72 (0.27-1.91)
	poor		5.44 (1.27-23.39)	5.54 (1.79-17.09)	3.11 (1.29-7.51)
Type of occupation	taxi driver			1.0 (-)	
	police driver			1.6 (0.53-4.84)	

Table 15a. Multivariate logistic regression of low back pain in the 12-months on alternative measures of daily cumulative vibration exposure to whole-body vibration (WBV) in the taxi drivers, police drivers and pooled group of drivers in the persistence group of the one-year follow-up period. Each measure of WBV exposure was included as a third based design variable, assuming the lowest quartile as the reference category. In the table are presented adjusted odds ratios (OR) and 95% confidence intervals (95% CI).

Measures of daily WBV exposure	Taxi drivers (n=209)			Police drivers (n=365)			All drivers (n=574)		
	Q1	Q2	Q3	Q1	Q2	Q3	Q1	Q2	Q3
Daily driving time (h)									
OR	1.0	0.23	0.25	1.0	0.6	0.52	1.0	0.54	0.49
(95% CI)	(-)	(0.02-2.15)	(0.03-1.97)	(-)	(0.15-2.35)	(0.15-1.79)	(-)	(0.18-1.58)	(0.14-1.79)
$A_v(8)$ (ms^{-2} r.m.s.)									
OR	1.0	0.23	0.25	1.0	0.5	0.66	1.0	0.57	0.53
(95% CI)	(-)	(0.02-2.15)	(0.03-1.97)	(-)	(0.13-1.98)	(0.17-2.54)	(-)	(0.2-1.64)	(0.15-1.84)
$A_{dom}(8)$ (ms^{-2} r.m.s.)									
OR	1.0	0.73	0.49	1.0	0.69	0.51	1.0	0.5	0.51
(95% CI)	(-)	(0.09-5.7)	(0.07-3.37)	(-)	(0.17-2.92)	(0.14-1.9)	(-)	(0.17-1.5)	(0.19-2.37)
VDV_{dom} ($ms^{-1.75}$)									
OR	1.0	0.62	0.45	1.0	0.56	0.42	1.0	0.49	0.51
(95% CI)	(-)	(0.08-14.89)	(0.07-2.98)	(-)	(0.13-2.49)	(0.11-1.64)	(-)	(0.17-1.41)	(0.13-1.99)

Taxi drivers- OR adjusted for age, weight, height, lifting at work, lifting at previous job, psychosomatic distress
Police drivers- OR adjusted for age, weight, lifting at work, bending at work, support at work, psychosomatic distress
Pooled group of all drivers- OR adjusted for age, height, weight, type of occupation, lifting, twisting and bending at work, lifting at previous job, psychosomatic distress

Table 15b. Multivariate logistic regression of low back pain in the 12-months on alternative measures of cumulative vibration exposure to whole-body vibration (WBV) in the taxi drivers, police drivers and pooled group of drivers in the persistence group of the one-year follow-up period. Each measure of WBV exposure was included as a third based design variable, assuming the lowest quartile as the reference category. In the table are presented adjusted odds ratios (OR) and 95% confidence intervals (95% CI).

Measures of daily WBV exposure		Taxi drivers (n=209)			Police drivers (n=365)			All drivers (n=574)		
		Q1	Q2	Q3	Q1	Q2	Q3	Q1	Q2	Q3
Exposure duration (yr)	OR	1.0	1.91	0.72	1.0	2.98	5.95	1.0	1.96	2.58
	(95% CI)	(-)	(0.28-13.01)	(0.1-5.23)	(-)	(0.87-10.21)	(1.69-21.03)	(-)	(0.78-4.9)	(1.08-6.19)
$\sum[t_i]$ (h $\times 10^3$)	OR	1.0	1.93	1.46	1.0	3.05	2.12	1.0	1.7	1.6
	(95% CI)	(-)	(0.23-16.06)	(0.15-13.85)	(-)	(0.71-13.04)	(0.61-7.44)	(-)	(0.55-5.27)	(0.55-5.27)
$\sum[a_{wsi}t_i]$(ms^{-2}h$\times 10^3$)	OR	1.0	9.71	1.2	1.0	3.85	2.44	1.0	2.39	2.28
	(95% CI)	(-)	(0.77-121.97)	(0.14-10.18)	(-)	(0.38-38.61)	(0.8-7.43)	(-)	(0.81-7.07)	(0.74-6.99)
$\sum[a_{wsi}^2 t_i]$ (m^{2}s^{-4}h $\times 10^3$)	OR	1.0	9.71	1.2	1.0	3.62	2.34	1.0	2.29	1.98
	(95% CI)	(-)	(0.77-121.97)	(0.14-10.18)	(-)	(0.85-15.51)	(0.67-8.19)	(-)	(0.75-6.97)	(0.64-6.17)
$\sum[a_{wsi}^4 t_i]$ (m^{4}s^{-8}h $\times 10^3$)	OR	1.0	9.71	1.2	1.0	3.62	2.34	1.0	2.86	1.92
	(95% CI)	(-)	(0.77-121.97)	(0.14-10.18)	(-)	(0.85-15.51)	(0.67-8.19)	(-)	(0.93-8.84)	(0.62-6.01)
$\sum[a_{wqi}t_i]$ (ms^{-2}h $\times 10^3$)	OR	1.0	9.71	1.2	1.0	3.21	2.53	1.0	2.41	1.72
	(95% CI)	(-)	(0.77-121.97)	(0.14-10.18)	(-)	(0.75-13.72)	(0.72-8.88)	(-)	(0.8-7.28)	(0.58-5.1)
$\sum[a_{wqi}^2 t_i]$ (m^{2}s^{-4}h $\times 10^3$)	OR	1.0	9.71	1.2	1.0	3.62	2.34	1.0	1.97	2.04
	(95% CI)	(-)	(0.77-121.97)	(0.14-10.18)	(-)	(0.85-15.51)	(0.67-8.19)	(-)	(0.63-6.1)	(0.64-6.56)
$\sum[a_{wqi}^4 t_i]$ (m^{4}s^{-8}h $\times 10^3$)	OR	1.0	9.71	1.2	1.0	3.62	2.34	1.0	2.56	1.67
	(95% CI)	(-)	(0.77-121.97)	(0.14-10.18)	(-)	(0.85-15.51)	(0.67-8.19)	(-)	(0.84-7.77)	(0.46-6.07)
$VDV_{Total\text{-dom}}$ (ms$^{-1.75}$)	OR	1.0	9.71	1.2	1.0	3.62	2.34	1.0	2.73	1.01
	(95% CI)	(-)	(0.77-121.97)	(0.14-10.18)	(-)	(0.85-15.51)	(0.67-8.19)	(-)	(0.9-8.34)	(0.24-4.18)

Taxi drivers- OR adjusted for age, weight, height, lifting at work, lifting at previous job, psychosomatic distress
Police drivers- OR adjusted for age, weight, lifting at work, bending at work, support at work, psychosomatic distress
Pooled group of all drivers- OR adjusted for age, height, weight, type of occupation, lifting, twisting and bending at work, lifting at previous job, psychosomatic distress

Table 15c. Multivariate logistic regression of low back pain in the 12-months on alternative measures of daily cumulative vibration exposure to whole-body vibration (WBV) in police drivers and pooled group of drivers in the incidence group of the one-year follow-up period. Each measure of WBV exposure was included as a third based design variable, assuming the lowest quartile as the reference category. In the table are presented adjusted odds ratios (OR) and 95% confidence intervals (95% CI).

Measures of daily WBV exposure	Police drivers (n=365)			All drivers (n=574)		
	Q1	Q2	Q3	Q1	Q2	Q3
Daily driving time (h)						
OR	1.0	8.24	7.69	1.0	3.21	1.68
(95% CI)	(-)	(1.27-53.43)	(1.58-37.4)	(-)	(0.86-12.07)	(0.41-6.86)
$A_v(8)$ (ms^{-2} r.m.s.)						
OR	1.0	10.85	9.84	1.0	2.82	2.02
(95% CI)	(-)	(1.64-71.63)	(1.84-52.58)	(-)	(0.76-10.44)	(0.5-8.16)
$A_{dom}(8)$ (ms^{-2} r.m.s.)						
OR	1.0	10.85	9.84	1.0	2.96	2.91
(95% CI)	(-)	(1.64-71.63)	(1.84-52.58)	(-)	(0.66-13.32)	(0.3-25.55)
VDV_{dom} ($ms^{-1.75}$)						
OR	1.0	10.85	9.84	1.0	2.78	2.24
(95% CI)	(-)	(1.64-71.63)	(1.84-52.58)	(-)	(0.76-10.15)	(0.49-10.32)

Police drivers- OR adjusted for age, weight, lifting at work, bending at work, support at work, psychosomatic distress
Pooled group of all drivers- OR adjusted for age, height, weight, type of occupation, lifting, twisting and bending at work, lifting at previous job, psychosomatic distress

Table 15d. Multivariate logistic regression of low back pain in the 12-months on alternative measures of cumulative vibration exposure to whole-body vibration (WBV) in police drivers and pooled group of drivers in the incidence group of the one-year follow-up period. Each measure of WBV exposure was included as a third based design variable, assuming the lowest quartile as the reference category. In the table are presented adjusted odds ratios (OR) and 95% confidence intervals (95% CI).

Measures of daily WBV exposure		Police drivers (n=365)			All drivers (n=574)		
		Q1	Q2	Q3	Q1	Q2	Q3
Exposure duration (yr)	OR	1.0	1.27	0.79	1.0	1.3	1.26
	(95% CI)	(-)	(0.38-4.23)	(0.19-3.32)	(-)	(0.48-3.56)	(0.45-3.6)
$\sum[t_i]$ (h $\times 10^3$)	OR	1.0	2.57	2.58	1.0	1.07	1.91
	(95% CI)	(-)	(0.51-12.87)	(0.53-12.56)	(-)	(0.3-3.87)	(0.51-7.14)
$\sum[a_{wsi}t_i]$($ms^{-2}h\times 10^3$)	OR	1.0	2.07	3.05	1.0	1.25	2.11
	(95% CI)	(-)	(0.29-14.82)	(0.72-12.93)	(-)	(0.36-4.36)	(0.61-7.32)
$\sum[a_{wsi}^2 t_i]$ ($m^2s^{-4}h \times 10^3$)	OR	1.0	2.57	3.08	1.0	1.21	2.21
	(95% CI)	(-)	(0.54-12.26)	(0.62-15.2)	(-)	(0.35-4.2)	(0.64-7.65)
$\sum[a_{wsi}^4 t_i]$ ($m^4s^{-8}h \times 10^3$)	OR	1.0	2.57	3.08	1.0	1.25	2.08
	(95% CI)	(-)	(0.54-12.26)	(0.62-15.2)	(-)	(0.36-4.33)	(0.62-7.03)
$\sum[a_{wqi}t_i]$ ($ms^{-2}h \times 10^3$)	OR	1.0	2.57	3.08	1.0	1.23	2.11
	(95% CI)	(-)	(0.54-12.26)	(0.62-15.2)	(-)	(0.35-4.28)	(0.62-7.14)
$\sum[a_{wqi}^2 t_i]$ ($m^2s^{-4}h \times 10^3$)	OR	1.0	2.57	3.08	1.0	1.21	1.83
	(95% CI)	(-)	(0.54-12.26)	(0.62-15.2)	(-)	(0.35-4.18)	(0.5-6.79)
$\sum[a_{wqi}^4 t_i]$ ($m^4s^{-8}h \times 10^3$)	OR	1.0	2.57	3.08	1.0	1.22	2.01
	(95% CI)	(-)	(0.54-12.26)	(0.62-15.2)	(-)	(0.35-4.28)	(0.52-7.85)
$VDV_{Total\text{-dom}}$ ($ms^{-1.75}$)	OR	1.0	2.57	3.08	1.0	1.35	1.59
	(95% CI)	(-)	(0.54-12.26)	(0.62-15.2)	(-)	(0.38-4.79)	(0.39-6.42)

Police drivers- OR adjusted for age, weight, lifting at work, bending at work, support at work, psychosomatic distress
Pooled group of all drivers- OR adjusted for age, height, weight, type of occupation, lifting, twisting and bending at work, lifting at previous job, psychosomatic distress