Risks of Occupational Vibration Exposures

VIBRISKS

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Title: Pooling of Longitudinal epidemiological surveys of drivers exposed to whole-body vibration in Italy, Sweden, the Netherlands and the United Kingdom

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1 Introduction

Work package 4, “WBV support and integration of results”, is designed to support the studies of disorders associated with exposures to whole-body vibration in Work package 5 “WBV Epidemiological studies” and the biodynamic modelling and experimental work conducted in work package 6 “WBV Experimental work”.

This document reports on a part of work conducted within work package 4 –.

Studies conducted in Italy, Sweden,Netherlands and United Kingdom following the VIBRISK protocol for whole

Prediction of spinal stress in different categories of drivers, based on biodynamic modelling and WBV experimental work, has been done by Partner FIOSH.

2 Objectives

The objectives with WP4, task 4.2,has been to;

(i) agree on and generate a common WBV data base in an accessible format for VIBRISKS partners

(ii) In collaboration between VIBRISKS partners conduct common data analysis and to report common findings

3 Epidemiological surveys of workers exposed to WBV

3.2 Baseline data

The international baseline dataset includes 1265 individuals all together, 1249 male (98.7 %) and 16 female (1.3 %), from Italy, United Kingdom, the Netherlands and Sweden.

Sweden received questionnaires and baseline databases from all countries in the VIBRISKS WP5 according to the protocol in WP4. Each countries questionnaire and

baseline database have been reviewed in order to determent differences and/or similarities. Through thorough inspection of each countries questionnaire, questions that were considered similar topics were be matched together and an English version variable legend with international variable names could be produced. To each question there were one or many variables with different coding in between countries. With the international variable legend as a starting point homogeneous variables that satisfy all countries demands were constructed. The database includes both variables that are consistent in between countries and variables that are country specific. For variables where the representation of the answers differs adjustment and rearrangement in the coding was preformed. In those cases where adjustment is not possible the result is country specific variables. The thorough variable reconstruction resulted in the pooled international baseline database. Background variables that was not present in all countries database, i.e. BMI, COUNTRY, AGE, BORNY (year of birth) and IDNR (international identification number) had to be created from predefined variables in order to describe the pooled database.

3.3 Italy

The baseline data from Italy contain 426 individuals, 423 male (99.30 %) and 3 (0.70 %) female. There are two different baseline databases for individuals in the Italian survey with differences in identification number, one contains 426 individuals and the other 628 individuals. Due to this difference the baseline database that could be matched to the follow-up database regarding identification number were used. As a result 202 individuals were lost from the baseline database and their corresponding dose values for variables DOSE8 – DOSE15 were lost as well.

The original baseline data from Italy contain 628 individuals, 625 male (99.52 %) and 3 (0.48 %) female.

3.4 Sweden

The baseline data from Sweden contain 311 individuals, 311 male (100 %).

The main occupation for the participants is forest work.

3.5 Netherlands

Netherlands

The baseline data from the Netherlands contain 318 individuals, 315 male (99.05 %) and 3 (0.95 %) female.

3.6 United Kindom

United Kingdom

The baseline data from United Kingdom contain 209 individuals, 199 male (95.22 %) and 10 (4.78 %) female. The main occupation for the individuals in the survey are taxi driving.

4 Follow-up data

The international follow-up database includes 1146 individuals, 871 male (98.86 %), 10 female (1.14 %) and 265 individuals without gender specification.

The convention of the international variable name list (from baseline) was followed by different degree in between countries. Due to this the international follow-up database contains both variables that are consistent in between countries and variables that are country specific. In order to get a homogeneous international follow-up database that has the same structure and variable names as for the baseline database methods comparable to those from baseline are used. In the absence of legends and English version questionnaires from a number of countries the interpretation of questions and variables not following the international convention or new questions became difficult. Adjustments and rearrangements in the coding of the variables were preformed as far as possible. But as a consequence a number of variables may have internal bias, due to interpretation and/or coding. The concerned variables are listed below for each country.

4.2 Italy

The follow-up data from Italy contain 426 individuals, 423 male (99.30 %) and 3 female

(0.70 %), for further details see baseline description. The international convention regarding the database was followed. There were only a few changes from baseline but everything was well documented. A number of variables had to be recoded in order to fit the international convention.

Variables that have not been interpreted due to unknown coding or likewise are W65_IT, W69_IT, W70_IT, W115_IT, W119_IT, W120_IT, W144_IT and W145_IT.

4.3 United Kingdom

The follow-up data from United Kingdom contained 144 individuals, 137 male (95.14 %) and 7 female (4.86 %). New individuals have entered the study at the follow-up this imply that there are no baseline observation for these individuals. The international convention has been followed. There is however no dose values in the follow-up survey, variables DOSE1 – DOSE15. A number of new country specific variables were created in the follow-up survey.

Variables that have not been interpreted due to unknown coding or likewise are W66_UK and W116_UK.

4.4 Netherlands

The follow-up data from the Netherlands contain 265 individuals. New individuals were entered in the cohort at the follow-up, this imply that there are no baseline observation for these individuals. Variables for SEX and AGE can not be found or calculated for the follow-up data.

The variable W14_NL has not been interpreted due to unknown coding or likewise.

4.5 Sweden

The follow-up data from Sweden contain 311 individuals, 311 male (100 %).

There are a number of new country specific variables in the follow-up survey.

5 Methods

The proportions with 95% confidence intervals (CI) were calculated by using Wilson-method recommended by Altman et al. [1] and are written separated with a semicolon after the proportion in the tables.

In the analysis of binary longitudinal outcomes, as the musculoskeletal pain outcomes used here, there are several different regression models to choose between. The decision of what model to use is dependent on what is in focus to model (association, development of symptom, risk etc.). One of the most common models used is the Cox regression [2] is a useful model. Another large group of models are the logistic regressions and especially marginal, conditional or transitional models [3, 4]. A traditional outcome in an epidemiological study is non-case/case or alive/dead (0/1). Death or case is also called an event. In the simples case this binary event is irreversible, that is when the event has happened the individuals can not go back to the previous stage. For example, at the beginning of the study all individuals are alive. The event death is such that when a person has died one is forever dead. For analyzing these events over time Cox regression is common and useful. The other kind of binary event is the reversible event, for example low back pain. At the start of the study persons could have low back pain and then later not have low back pain and then even later again have low back pain (1 0 1). If the choice of cut-off and hence the definition of the event, is straight forward, analyzing the data with for example a binary logistic model works well [2]. In the present study the events are registered at two time points, baseline and follow-up, and at both baseline and follow-up persons can either be non-cases or cases. There are mainly three models suggested in the literature, marginal models, conditional models and transition models, to analyze these data in a longitudinal way [3, 4]. One could also choose Cox regression for the analyses, but would then throw away all subjects having symptoms at baseline and would then not be able to discuss the effect of exposure to whole-body vibration on the process of persistent (chronic) symptoms.

In the analysis below the transitional model is used, which imply that we analyzed the effect of exposure to whole-body vibration on both those who had musculoskeletal pain and those who had no musculoskeletal pain at baseline. The actual way this was performed in these preliminary analyses is straight forward by separately analyzing those who had musculoskeletal pain and those who had no musculoskeletal pain at baseline with ordinary binary logistic regression (using Proc logistic in SAS software ver.9.0).

6 Preliminary results

Among those, in the total European sample, who did not have symptoms at start 26% (21,3 ; 32,4) developed low back pain, 13% (9,8 ; 17,5) developed neck pain and 16% (12,6 ; 20,5) developed shoulder pain during the study period. Among those, in the total European sample, who had symptoms at start 78% (72,4 ; 82,0) still had low back pain, 55% (48,8 ; 61,6) still had neck pain and 59% (52,2 ; 66,1) still had shoulder pain at follow-up.

6.2 Low back pain

The effect of exposure to whole-body vibration on developing low back pain (column baseline=0 in Table 1) is not clear for any of the measures of exposure used. The OR are both above and below 1,0 and they are not significant with only one exception. One explanation could be a healthy worker effect.

The analysis of the association between exposure to whole-body vibration and persistent (chronic) low back pain (column baseline=1 in Table 1) indicate a negative effect of exposure, but is not statistically significant for all of the measures or levels of exposure used.

Interesting is that it is a clear difference in the OR of developing low back pain (column baseline=0 in Table 1) between the countries. The odds for developing low back pain in United Kingdom are statistically significant lower than the odds in the Netherlands, Italy and Sweden. The reason for this is not clear and need further investigation, but part of the explanation might be that the sample in United Kingdom consist of taxi drivers, while the samples from the other countries consists of other vehicles (trucks, lorries, forestry machinery etc.). This means that both the vibration exposure and other work environment factors could differ more between United Kingdom and the other countries.

The pattern of differences in the odds between countries is also present in the analysis of persistent low back pain (column baseline=1 in Table 1), but is then only significant for the Netherlands compared to United Kingdom. That is, the odds for persistent low back pain in United Kingdom might be lower then in the other countries.

Table 1 OR of symptoms. q0=minimum value-25 percentile of dose, q1=25 to 50 percentile of dose, q2=50 to 75 percentile of dose, q3=75 percentile to maximum value of dose.

Low back pain (last 12 months)				
	Baseline=0		Baseline=1	
	OR	95% CI	OR	95% CI
Dose1	N=384		N=537	
q1/q0	0,82	0,433 ; 1,56	1,4	0,785 ; 2,48
q2/q0	1,3	0,660 ; 2,58	2,2	1,21 ; 4,03
q3/q0	0,72	0,319 ; 1,61	1,2	0,601 ; 2,40
Age	1,0	0,978 ; 1,03	1,0	0,970 ; 1,02
Bmi	1,0	0,945 ; 1,07	1,0	0,950 ; 1,06
Netherlands/UK	5,9	1,90 ; 18,5	3,5	1,38 ; 8,84
Italy /UK	4,3	1,42 ; 13,03	1,9	0,827 ; 4,48
Sweden/UK	4,5	1,42 ; 14,52	1,8	0,753 ; 4,54
Dose3	N=384		N=537	
q1/q0	1,0	0,548 ; 1,95	2,3	1,28 ; 4,04
q2/q0	0,73	0,351 ; 1,52	1,5	0,833 ; 2,78
q3/q0	1,0	0,373 ; 1,93	1,3	0,627 ; 2,68
Age	1,0	0,979 ; 1,03	0,99	0,970 ; 1,02
Bmi	1,0	0,939 ; 1,07	1,0	0,954 ; 1,07
Netherlands/UK	5,3	1,69 ; 16,45	3,7	1,45 ; 9,43
Italy /UK	3,9	1,27 ; 11,76	2,1	0,885 ; 4,96
Sweden/UK	4,5	1,32 ; 15,54	2,2	0,834 ; 6,05
Dose14 (A(8) current rms)	N=220		N=275	
q1/q0	0,49	0,176 ; 1,35	1,6	0,619 ; 4,22
q2/q0	0,29	0,100 ; 0,823	1,6	0,583 ; 4,29
q3/q0	0,38	0,111 ; 1,28	1,0	0,335 ; 3,05
Age	1,0	0,968 ; 1,02	1,0	0,972 ; 1,03
Bmi	1,0	0,919 ; 1,10	1,1	0,978 ; 1,18
Netherlands/UK	6,9	2,14 ; 22,15	4,2	1,63 ; 10,96
Sweden/UK	9,0	2,00 ; 40,77	2,4	0,710 ; 8,09

6.3 Neck pain

The effect of exposure to whole-body vibration on developing neck pain (column baseline=0 in Table 1) is not clear for any of the measures of exposure used. The OR are both above and below 1,0 and they are not significant.

The analysis of the connection between exposure to whole-body vibration and persistent (chronic) neck pain (column baseline=1 in Table 2) is not clear. Only for Dose14 the results indicate a negative effect of exposure. For Dose1 and Dose3 the results are non-informative.

It seems to be differences in the odds of developing neck pain (column baseline=0 inTable 2) between the countries. The odds for developing neck pain seem to be higher in United Kingdom than the odds in the Netherlands. The odds for developing neck pain seem to be lower in United Kingdom than in Italy and Sweden. Note though that these results are not statistically significant for all comparisons.

The same pattern of differences in the odds between countries is also present in the analysis of persistent neck pain (column baseline=1 in Table 2), but not all comparisons are statistically significant.

6.4 Shoulder pain

The effect of exposure to whole-body vibration on developing shoulder pain (column baseline=0 in Table 3) is not clear for any of the measures of exposure used. The OR are both above and below 1,0 and they are not significant with only one exception.

The analysis of the connection between exposure to whole-body vibration and persistent (chronic) shoulder pain (column baseline=1 in Table 3) is non-informative, as there is no pattern and the results are statistically non-significant.

For shoulder pain there was also a tendency of differences in odds between countries. For developing shoulder pain the odds for the Netherlands and United Kingdoms are approximate equal between the countries. The odds for developing shoulder pain seemed to be higher for both Italy and Sweden than for United Kingdoms. Note that neither of the OR was statistically significant (column baseline=0 in Table 3). For remaining with shoulder pain the pattern was slightly different in that the Netherlands seemed to have lower odds then United Kingdom. Here too the OR were not statistically significant (column baseline=1 in Table 3).

Table 2 OR of symptoms. q0=minimum value-25 percentile of dose, q1=25 to 50 percentile of dose, q2=50 to 75 percentile of dose, q3=75 percentile to maximum value of dose.

Neck pain (last 12 months)				
	Baseline=0		Baseline=1	
	OR	95% CI		OR
Dose1	N=530		N=387	
q1/q0	0,98	0,412 ; 1,54	0,87	0,428 ; 1,76
q2/q0	1,1	0,534 ; 2,10	0,76	0,382 ; 1,52
q3/q0	0,72	0,290 ; 1,79	1,4	0,583 ; 3,26
Age	0,98	0,954 ; 1,01	0,99	0,962 ; 1,02
Bmi	1,0	0,963 ; 1,09	1,0	0,978 ; 1,12
Netherlands/UK	0,53	0,160 ; 1,74	0,30	0,107 ; 0,837
Italy /UK	1,6	0,596 ; 4,47	3,0	1,18 ; 7,76
Sweden/UK	3,2	1,08 ; 9,18	3,2	1,19 ; 8,54
Dose3	N=530		N=387	
q1/q0	0,92	0,471 ; 1,782	1,1	0,576 ; 2,19
q2/q0	0,80	0,370 ; 1,72	0,50	0,246 ; 1,01
q3/q0	1,0	0,423 ; 2,60	1,8	0,768 ; 4,32
Age	0,98	0,953 ; 1,01	0,98	0,957 ; 1,01
Bmi	1,0	0,962 ; 1,09	1,1	0,987 ; 1,13
Netherlands/UK	0,48	0,145 ; 1,59	0,25	0,087 ; 0,719
Italy /UK	1,5	0,555 ; 4,28	2,3	0,904 ; 6,07
Sweden/UK	2,8	0,874 ; 9,13	2,1	0,720 ; 6,087
Dose14 (A(8) current rms)	N=278		N=213	
q1/q0	0,89	0,235 ; 3,38	1,4	0,344 ; 5,30
q2/q0	0,81	0,196 ; 3,31	2,9	1,04 ; 8,17
q3/q0	2,1	0,478 ; 8,88	4,1	1,24 ; 13,64
Age	0,98	0,954 ; 1,02	1,0	0,967 ; 1,03
Bmi	1,1	0,971 ; 1,22	1,1	1,02 ; 1,24
Netherlands/UK	0,51	0,152 ; 1,74	0,28	0,093 ; 0,859
Sweden/UK	2,2	0,487 ; 10,24	1,5	0,381 ; 5,66

Table 3 OR of symptoms. q0=minimum value-25 percentile of dose, q1=25 to 50 percentile of dose, q2=50 to 75 percentile of dose, q3=75 percentile to maximum value of dose.

Shoulder pain (last 12 months)				
	Baseline=0		Baseline=1	
	OR	95% CI	OR	95% CI
Dose1	N=665		N=248	
q1/q0	1,9	0,994 ; 3,53	0,62	0,258 ; 1,49
q2/q0	2,2	1,12 ; 4,15	1,1	0,481 ; 2,71
q3/q0	1,8	0,791 ; 4,01	1,0	0,392 ; 2,60
Age	1,0	0,976 ; 1,03	0,99	0,959 ; 1,02
Bmi	0,97	0,904 ; 1,03	1,0	0,954 ; 1,09
Netherlands/UK	0,99	0,359 ;2,75	2,5	0,787 ; 7,76
Italy /UK	1,6	0,616 ; 3,90	1,4	0,466 ; 4,42
Sweden/UK	2,4	0,900 ; 6,41	2,1	0,694 ; 6,59
Dose3	N=665		N=248	
q1/q0	1,8	0,958 ; 3,26	0,83	0,374 ; 1,88
q2/q0	1,8	0,898 ; 3,58	1,05	0,458 ; 2,40
q3/q0	1,7	0,729 ; 3,87	0,98	0,395 ; 2,41
Age	1,0	0,982 ; 1,03	1,0	0,965 ; 1,02
Bmi	0,96	0,903 ; 1,03	1,0	0,958 ; 1,10
Netherlands/UK	0,99	0,354 ; 2,75	2,9	0,939 ; 8,90
Italy /UK	1,6	0,611 ; 4,08	1,8	0,594 ; 5,18
Sweden/UK	2,3	0,804 ; 6,83	2,4	0,735 ; 7,98
Dose14 (A(8) current rms)	N=319		N=168	
q1/q0	1,7	0,589 ; 5,08	0,94	0,302 ; 2,95
q2/q0	2,0	0,677 ; 5,72	2,3	0,700 ; 7,86
q3/q0	1,0	0,296 ; 3,425	1,4	0,338 ; 5,64
Age	0,99	0,962 ; 1,02	1,0	0,980 ; 1,04
Bmi	1,0	0,923 ; 1,13	1,0	0,940 ; 1,12
Netherlands/UK	0,94	0,338 ; 2,63	2,8	0,886 ; 8,66
Sweden/UK	2,5	0,749 ; 8,41	1,7	0,357 ; 8,42

7 Summary

In the total European sample about 1 of 4 subjects developed low back pain. About half as many subjects developed neck pain or shoulder pain. Among those who had musculoskeletal pain at baseline most of the subjects still had low back pain at follow-up and about half of the subjects still had neck and shoulder pain.

The effect of exposure to whole-body vibration on persistent musculoskeletal pain seemed to be negative for low back pain. For neck pain this association was only present for A(8) (i.e. current rms).

There seemed to be differences between countries were United Kingdom had lower odds, then all the other countries, both to develop and to persistent (chronic) low back pain.

For neck pain Netherlands had the lowest odds both to develop and to persistent (chronic) pain.

The analysis above indicated that the models used were too simple to explain the variation in the data. Unsatisfying analysis were performed trying to use some of the lifestyle (sport activities, alcohol use etc.) and ergonomic factors (working in bent or twisted positions etc.) included in the data. These analyses gave neither significant variables nor more explanation to variation. As they were rough analysis it would be satisfying to work more with for example combinations of ergonomic work conditions etc and to include this in a model.

Even if the above are preliminary analysis with limitations the consistent patterns are of interest.

8 References

Altman, D. G., D. Machin, et al. (2000). Statistics with confidence, BMJ Books.

Rothman K J, Greenland S, Modern epidemiology, Lippincott-Raven Publisher, 1998.

Greenland, S. (1994). "Alternative models for ordinal logistic regression." Stat Med 13(16): 1665-77.

Viikari-Juntura, E., R. Martikainen, et al. (2001). "Longitudinal study on work related and individual risk factors affecting radiating neck pain." Occup Environ Med 58(5): 345-52.

ISO 2631-1, Mechanical vibration and shock. Evaluation of human exposure to whole-body vibration. Part 1: General requirements.

ISO/DIS 2631-5, Mechanical vibration and shock. Evaluation of human exposure to whole-body vibration. Part 5: Methods for evaluation of vibration containing multiple shocks.

prEN 14253:2002(E), Mechanical vibration. Measurement and calculation of occupational exposure to whole-body vibration with reference to health. Practical guidance.