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Professional driving and prolapsed lumbar intervertebral disc diagnosed by magnetic resonance imaging – a case–control study

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Abstract

Objectives—The aim of this study was to investigate whether whole-body vibration (WBV) is associated with prolapsed lumbar intervertebral disc (PID) and nerve root entrapment among patients with low-back pain (LBP) undergoing magnetic resonance imaging (MRI).

Methods—A consecutive series of patients referred for lumbar MRI because of LBP were compared with controls X-rayed for other reasons. Subjects were questioned about occupational activities loading the spine, psychosocial factors, driving, personal characteristics, mental health, and certain beliefs about LBP. Exposure to WBV was assessed by six measures, including weekly duration of professional driving, hours driven at a spell, and current 8-hour daily equivalent root-mean-square acceleration A(8). Cases were sub-classified according to whether or not PID/nerve root entrapment was present. Associations with WBV were examined separately for cases with and without these MRI findings, with adjustment for age, sex, and other potential confounders.

Results—Altogether, 237 cases and 820 controls were studied, including 183 professional drivers and 176 cases with PID and/or nerve root entrapment. Risks associated with WBV tended to be lower for LBP with PID/nerve root entrapment but somewhat higher for risks of LBP without these abnormalities. However, associations with the six metrics of exposure were all weak and not statistically significant. Neither exposure–response relationships nor increased risk of PID/nerve root entrapment from professional driving or exposure at an A(8) above the European Union daily exposure action level were found.

Conclusions—WBV may be a cause of LBP but it was not associated with PID or nerve root entrapment in this study.

Keywords

back pain; disc pathology; whole-body vibration

Many studies have found an association of whole-body vibration (WBV) with low-back pain (LBP) and sciatica, and some indicate an increased risk of prolapsed intervertebral disc (PID) specifically (1–9). However, the latter have seldom confirmed diagnosis beyond self-

report, so it remains uncertain whether WBV is a cause of PID. The increased use of magnetic resonance imaging (MRI) offers new opportunities to distinguish cases with PID and nerve root entrapment. In the present paper, we report a case-control study of MRI-investigated LBP, which examines the association of PID and nerve root entrapment with occupational exposure to WBV.

Methods

The main methods have been described elsewhere (9). In brief, the study population comprised working-aged adults resident in the area served by a public hospital. Cases were a consecutive series referred to the radiology department at that hospital or to two local private hospitals for MRI of the lumbar spine during 2003–2006. Controls were investigated by radiography while attending the public hospital's emergency department over 2003–2006. They fulfilled the same residency requirement and were group-matched to cases by sex and age.

Participants completed a questionnaire on occupational history, work activities (digging, lifting, trunk bending/twisting), professional driving, and exposure to WBV (vehicle types, duration, intensity), demographic characteristics, somatizing tendency (10), low mood (11), consulting behavior (12), fear-avoidance beliefs (13), and beliefs regarding the work-relatedness of LBP. Cases were asked about their LBP symptoms and disability. Exposure to WBV in their latest job was assessed by six metrics: (i) professional driving (>1 hour/day); (ii) professional driving (>3 hours consecutively); (iii) weekly hours driven for the vehicle most used; (iv) weekly hours driven for all vehicles (none, <16, 16); (v) maximum-root-mean square (rms) acceleration of any vehicle (0, -0.5, 0.6 ms⁻² rms) and (vi) A(8) rms (< or 0.5 ms⁻² rms [the action level in the European Union (EU) Physical Agents (vibration) Directive (14)]. Metrics (v) and (vi) were derived from driving times and imputed vibration magnitudes of vehicles (9, 15).

Blinded to work history, radiologists assessed MRI scans using a repeatable standardized protocol (16). Images were graded at three spinal levels (L3/L4, L4/L5, L5/S1) for: (i) disc herniation (protrusion, herniation, or disc sequestration); and/or (ii) nerve root entrapment (displacement or compression).

Analysis focused on cases whose latest LBP episode (that since last pain-free for 1 month) began in their current/most recent job and controls who gave a current or recent job history. Associations were summarized by odds ratios (OR) with 95% confidence intervals (95% CI). Separate logistic regression models were constructed for each metric of WBV. All were adjusted for age and sex as matching variables. Additional adjustment was made for well-recognized risk factors for LBP previously associated with case presentation in the sample (9) (see table 1).

Finally, as some cases came from the private hospitals, potential selection bias was explored by repeating analyses without the private cases.

Results

In all, 237 cases and 820 controls were analyzed. [Response rates, reasons for exclusion, control diagnoses, and patient characteristics were identical to those cited previously (9), save for 15 excluded cases with missing scans.] The groups were well matched by age, sex, and interval from starting their latest job. Cases with relevant MRI findings (N=174) were similar to other cases in their duration of current LBP, disability in the past four weeks, and most personal and occupational risk factors.

The sample included 143 professional drivers (130 of whom drove cars). Table 1 shows associations with WBV adjusted for age and sex, and then additionally for other risk factors for LBP. Partially and fully adjusted models produced similar risk estimates. In cases without PID/nerve root entrapment, slightly elevated risks (OR 1.4) were found for driving for 3 hours continuously and driving in total >0–<15 hours/week; while, in cases with PID/nerve root entrapment, reduced risks were sometimes found. However, no associations were significant at the 5% level and overall risks from being a professional driver or from an A(8) above the EU action level were close to unity, irrespective of MRI findings.

Table 2 presents findings after excluding private cases. Again, no associations were significant at the 5% level; but the inverse association of some WBV metrics with relevant MRI pathology was more marked, and risks were more than doubled among scan-negative cases who drove for >3 hours continuously and drivers whose A(8) exceeded the EU action level. To explore whether lower risks from driving among those with PID/nerve root entrapment could represent selection out of driving in previous employments, we assessed the proportion of subjects who had had a driving job for 1 year but had left such work when scanned: 55% of scan-positive cases had left such work versus 57% of scan-negative cases and 51% of controls.

Discussion

Previously, in this sample, we found no important associations between WBV and LBP severe enough to occasion lumbar MRI imaging but strong associations with several physical and psychosocial risk factors for LBP (9). This analysis, stratified by MRI evidence of PID and/or nerve root entrapment, indicated no elevated risks from WBV for these pathologies but somewhat elevated risks for LBP in their absence. One possible interpretation is that WBV (or sitting while driving) increases the risk of LBP but not the risk of PID or nerve root entrapment.

Our study had certain limitations. Participation was incomplete, but this would bias analysis only if the relation between driving and MRI appearance differed by response status, which seems unlikely. Exposure ascertainment was retrospective and selection bias might arise if drivers with LBP avoided future WBV exposure. However, the proportion of cases holding a previous driving job for >1 year but no longer was similar to controls, and similar by scan result. Non-differential errors in exposure assessment could bias risk estimates to the null for complex metrics relying on recalled exposure times and imputed estimates of vibration magnitude. However, several exposure measures were straightforward (eg, driving for >1 hour/week); evidence exists that occupational drivers can assess driving times accurately (17); we focused on recent exposures for which reporting should be more dependable and provided an aide-memoire checklist of sources. In any event, such errors are unlikely to explain differences of association between MRI-defined subgroups.

Nor is it likely that confounding explains such differences. The assessed risk factors for LBP were similarly frequent in the two MRI-defined case subgroups and adjustment changed risk estimates only marginally.

More telling is the source of recruitment. Risks became doubled only in a sensitivity analysis that excluded private hospital cases. This strengthened associations between WBV and LBP in the absence of PID/nerve root entrapment and, if anything, reduced estimates of risk for LBP associated with these pathologies. Analyses in table 1 had the advantage that they included both private and non-private cases from the study population, while controls should have provided representative exposure information on those at risk of becoming cases (emergencies were treated only at the public hospital). However, risks from WBV

could be underestimated if private cases were investigated by MRI at a lower-severity threshold. Conversely, risk estimates in table 2 would be underestimated if privately treated patients were less exposed to WBV. Importantly, neither analysis provided support for a positive association of WBV with PID or nerve root entrapment.

Associations between WBV and LBP have been observed frequently. Radiating leg pain and PID have also been associated with WBV (1–9); but only a few studies have focused on PID diagnosed objectively. In these, the findings have been less clear-cut. One case–control study reported an elevated risk of PID among those who sat most of the time in a motor vehicle [relative risk (RR) 2.75] (7). However, surgically confirmed cases constituted only ten matched pairs and, in this subset, the RR for driving was lower (1.3). A larger study, in which PID was surgically corroborated in half of cases, found slightly elevated risks among drivers of certain cars, but not among truck or van drivers (8). A study comparing machine drivers and carpenters with office workers, found higher risks of MRI-diagnosed lumbar anterior disc bulges among the machine drivers (OR elevated 3–4 fold), but reduced risks of posterior bulging (OR 0.6–0.9) (18); disc bulges and machine driving were independently associated with sciatic pain (19). A study of monozygotic twins discordant for occupational driving history found no relationship between driving and MRI-diagnosed lumbar disc bulges or herniations (20). A case–control study of MRI- or computed tomography (CT)-confirmed acute PID showed a trend in risk with lumbar spinal force but no significant trend with lifetime hours of WBV (21). A survey of Indian tractor driver farmers found they were no more likely than non-farmers to have disc bulging on MRI, despite having more work-related backache (22).

The hypothesis that WBV causes LBP (and sciatica) but is not an important cause of PID is thus compatible with the broad literature on drivers' symptoms and objectively diagnosed PID. However, it requires corroboration in further studies that verify diagnoses objectively over a more extreme range of exposure circumstances; this does not preclude the possibility that WBV causes other degenerative disc pathology.

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Table 1

Relationship of driving and whole body vibration to magnetic resonance imaging (MRI)-diagnosed disc herniation and/or nerve root compression or displacement. Separate models were constructed for each vibration variable. [OR=odds ratio; 95% CI=95% confidence interval; rms=root mean square.]

Vibration exposure	Controls (N=820)			Cases with disc herniation and/or nerve root compression/displacement on MRI (N=176)			Cases without disc herniation and/or nerve root compression/displacement on MRI (N=61)							
	N	%		N	%	OR 95% CI ^a	N	%	OR 95% CI ^a					
Professional driving (1 hours/day)	677	82.6	147	83.5	1	..	1	82.0	1	..	1	..		
Yes	143	17.4	29	16.5	0.8	0.5–1.3	0.8	0.5–1.3	1.1	18.0	1.1	0.5–2.2	1.1	0.5–2.2
Professional driving (3 hours/time)	765	93.3	163	92.6	1	..	1	56	91.8	1	..	1	..	
Yes	55	6.7	13	7.4	1.0	0.5–1.8	0.9	0.5–1.8	1.3	8.2	1.3	0.5–3.5	1.4	0.5–4.1
Average hours driven/week for commonest source	677	82.6	147	83.5	1	..	1	50	82.0	1	..	1	..	
<16	67	8.2	19	10.8	1.2	0.7–2.0	1.2	0.7–2.2	5	8.2	1.0	0.4–2.7	1.1	0.4–3.1
16	76	9.3	10	5.7	0.5	0.2–1.0	0.5	0.2–1.0	6	9.8	1.1	0.4–2.9	1.0	0.4–2.7
Total hours driven/week, all sources	677	82.6	147	83.5	1	..	1	50	82.0	1	..	1	..	
Not a regular driver	54	6.6	17	9.7	1.3	0.7–2.3	1.4	0.7–2.5	5	8.2	1.3	0.5–3.3	1.4	0.5–3.9
<15	89	10.9	12	6.8	0.5	0.3–1.0	0.5	0.2–1.0	6	9.8	1.0	0.4–2.4	0.8	0.3–2.2
15	677	82.6	147	83.5	1	..	1	50	82.0	1	..	1	..	
Max rms of any machine (ms ⁻²)	87	10.6	21	11.9	1.0	0.6–1.7	1.0	0.6–1.7	6	9.8	1.0	0.4–2.4	1.0	0.4–2.5
Not a regular driver	56	6.8	8	4.6	0.5	0.2–1.2	0.5	0.2–1.2	5	8.2	1.3	0.5–3.5	1.1	0.4–3.3
0.5														
0.6														

Vibration exposure	Controls (N=820)		Cases with disc herniation and/or root compression/displacement on MRI (N=176)				Cases without disc herniation and/or nerve root compression/displacement on MRI (N=61)			
	N	%	N	%	OR	95% CI ^a	OR	95% CI ^a	OR	95% CI ^b
Current rms A(8) (ms ⁻²)										
<0.5	697	85.0	149	84.7	1	..	1	1
0.5	123	15.0	27	15.3	0.9	0.5-1.4	0.9	0.5-1.5	1.0	0.4-2.2

^a Adjusted for age (in 3 bands) and sex.

^b Adjusted for age (in 3 bands), sex, BMI (in 3 bands), somatising tendency (in 3 bands), SF-36 mental health score (in 3 bands), smoking status (current, ex, never smoker), propensity to consult over back pain (in three bands), fear avoidance beliefs (in three bands), belief in work as a cause of back pain (in three bands), occupational digging and/or lifting (in two bands) and occupational bending and/or twisting (in two bands).

Table 2

Relationship of driving and whole body vibration to MRI-diagnosed disc herniation and/or nerve root compression or displacement, with analysis restricted to subjects from the public hospital. Separate models were constructed for each vibration variable. [OR=odds ratio; 95% CI=95% confidence interval; rms=root mean square.]

Vibration exposure	Cases with disc herniation and/or nerve root compression/displacement on MRI (N=91)				Cases without disc herniation and/or nerve root compression/displacement on MRI (N=36)			
	N	%	OR ^a	95%CI	N	%	OR ^a	95%CI
Professional driving (>=1hrs/day)								
No	78	85.7	1	..	28	77.8	1	..
Yes	13	14.3	0.7	0.3-1.3	8	22.2	1.7	0.7-4.2
Professional driving (>=3hrs/time)								
No	84	92.3	1	..	32	88.9	1	..
Yes	7	7.7	0.9	0.4-2.3	4	11.1	2.3	0.7-7.8
Average hrs driven/week for commonest source								
None	78	85.7	1	..	28	77.8	1	..
<16	9	9.9	1.1	0.5-2.4	3	8.33	1.3	0.4-4.7
16	4	4.4	0.3	0.1-1.0	5	13.9	2.1	0.6-6.6
Total hrs driven/week, all sources								
Not a regular driver	78	85.7	1	..	28	77.8	1	..
<15	7	7.7	1.1	0.5-2.6	3	8.3	1.6	0.4-6.0
15	6	6.6	0.4	0.2-1.1	5	13.9	1.7	0.5-5.3
Max r.m.s. of any machine (ms-2)								
Not a regular driver	78	85.7	1.0	1.0-1.0	28	77.8	1	..
0.5	7	7.7	0.7	0.3-1.6	5	13.9	1.9	0.7-5.5
0.6	6	6.6	0.7	0.3-1.7	3	8.3	1.3	0.3-5.2
Current r.m.s. A(8) (ms-2)								
<0.5	80	87.9	1	..	28	77.8	1	..

Vibration exposure	Cases with disc herniation and/or nerve root compression/displacement on MRI (N=91)			Cases without disc herniation and/or nerve root compression/displacement on MRI (N=36)		
	N	%	OR ^a 95%CI	N	%	OR ^a 95%CI
0.5	11	12.1	0.6 0.3-1.3	8	22.2	2.1 0.8-5.5

^a Adjusted for age (in 3 bands), sex, BMI (in 3 bands), somatizing tendency (in 3 bands), SF36 mental health score (in 3 bands), smoking status (current, ex, never smoker), propensity to consult over back pain (in three bands), fear avoidance beliefs (in three bands), belief in work as a cause of back pain (in three bands), occupational digging and/or lifting (in two bands) and occupational bending and/or twisting (in two bands).