BACK PROBLEMS AMONG CAR DRIVERS: A SUMMARY OF STUDIES DURING THE LAST 30 YEARS

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Abstract

This paper summarises studies of low back problems among car drivers published during the last three decades. Twenty-one articles, published between 1975 and 2004, were selected and reviewed. Case-control studies have been reported in six papers, cross-sectional studies in thirteen papers and longitudinal studies in two papers. Although evidence is often sparse, most of the studies concluded that exposure to whole-body vibration associated with driving was linked to an increased risk of low back pain.

1. Introduction

In 1990, Griffin reviewed 135 studies of whole-body vibration and health problems published between 1944 and 1988. The study populations were mostly tractor drivers, truck drivers, bus drivers, drivers of heavy machinery (earth moving equipment operators, crane operators, excavator operators, etc.) and helicopter pilots. The most frequently reported problems were back problems (degeneration of spinal vertebrae, herniated discs, osteoarthritis, etc.) followed by disorders of the stomach, reproductive system and vestibular and visual problems.

Seidel and Heide (1986) analysed 78 papers (published prior to 1982) related to occupational exposures to whole-body vibration and problems of the musculoskeletal and peripheral nervous system, digestive system, reproductive system and vestibular system. They concluded that after long-term exposure to whole-body vibration, spine and peripheral nervous system disorder increased.

Wikström *et al.* (1994) reviewed 45 studies (published between 1958 and 1992) of long-term exposure to whole-body vibration. The main conclusion was that many years of exposure to whole-body vibration might contribute to injuries and disorders of the lower back.

Bovenzi and Hulshof (1999) presented a review of 45 epidemiological studies (published from 1986 to 1997) describing the occurrence of low back disorders in occupational groups of drivers (mainly truck, tractor, bus drivers and crane operators). The review of the selected studies suggested that occupational exposure to whole-body vibration is associated with an increased risk of low back pain.

Lings and Leboeuf-Yde identified 24 studies (published from 1992 to 1999) and concluded it was not possible to decide whether exposure to whole-body vibration alone or whole-body vibration exposure in combination with other factors was a cause of low back pain.

The aim of this paper is to review epidemiological studies of car drivers published during the past thirty years and consider evidence for low back problems associated with vehicular vibration.

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2. Methods

2.1 Source of the studies

Many of the reviewed epidemiological studies were found in the Human Response to Vibration Literature Collection at the Institute of Sound and Vibration Research at the University of Southampton, United Kingdom. A search for other related papers was conducted through the Internet by using Web Cat (the University of Southampton Library computerised catalogue) and the database Medline (National Library of Medicine, United States of America). Used search terms were: whole-body vibration, low back pain, herniated lumbar disc, driving, and epidemiology. Only epidemiological studies concerned with health problems due to driving a car were analysed.

2.2 Analysis of the studies

Each study was analysed and summarised in tabular form under nine headings:

- Author and year
- Study design
- Subject group
- Control group
- Data source (e.g. questionnaire or medical examination)
- Confounding variables that were controlled
- Exposure description
- Results
- Author's conclusion

3. Results

In this paper, 21 of the epidemiological studies are reviewed. Only studies concerned with the relationship between car driving and low back problems are included (Appendix I).

Six studies had a case-control design [1, 2, 6, 7, 12, 16]. In a case-control study, individual cases of disease are matched with individuals from a control group; the matching may be based on age, gender, etc. (Griffin, 1990). Thirteen studies used a cross-sectional design [3-5, 8, 10, 13-15, 17-21]. A cross-sectional study depends on a single examination of the relationship between disease and other variables of interest as they exist in the selected population (Barker and Rose, 1990).

Two studies had a longitudinal design [9, 11]. In a longitudinal study (cohort study) subjects are followed over time with continuous or repeated monitoring of risk factors or health outcomes, or both (Coggon *et al.,* 1993). In one longitudinal study, subjects with low back pain were followed over the period of 12 months [9]; in the other study, car drivers with low back pain were followed-up after nine years [11].

Two studies have been conducted with rally drivers [16, 17], one with professional drivers [11] and one with commercial travellers [9]. One study has been conducted with workers in the steel industry [10] and another with workers of an electricity and gas company [21]. The remaining fifteen studies used populations from the general public.

Some authors subdivided their study population into subgroups by some characteristic. In a few studies, the population consisted of subgroups defined according to the occurrence of back problems (e.g. moderate pain versus severe pain or no pain, acute pain versus chronic pain) [3, 5, 6]. In other studies, the population was divided by type of occupation [12-14, 18].

The control groups consisted of subjects who did not report any back pain problems (especially for case-control studies), or subjects whose exposure to car driving was minimal.

The methods, and how the study population and the control population were chosen, appeared to be clearly described in seventeen studies [1-3, 5-7, 9-12, 14-18, 20, 21]. The response rate and the exclusion of inappropriate subjects were reported in eight studies [1, 2, 5, 8, 12, 14, 17, 18].

Four different methods of collecting information were used: questionnaire, medical interviews, medical examinations, and health registers. In eleven studies the source of information was a health questionnaire [5, 7, 8, 10, 12, 14, 15, 17-19, 21], which was mostly based on the Nordic Musculoskeletal Questionnaire established by Kuorinka *et al.* (1987). In only a few papers was it reported how the questionnaire had been modified for the selected population [5, 10, 14, 17, 18]. One study combined a questionnaire with a medical interview [12]. Ten studies used an interview [1-4, 6, 9, 12, 13, 16, 20] as the source of information and one study collected the material from registers (a central population register, a national inpatient register and administrative registers on economic activity and occupational activity) [11]. Six studies combined an interview or questionnaire with a medical test (*X*-rays, physical measurements) [1, 2, 6, 9, 14, 16].

Almost all studies clearly described the methods for analysing whether diseases were associated with population characteristics. Studies used odds ratios and relative risk as quantitative measures of the risk associated with a specific factor. Eleven studies used logistic regression to calculate odds ratios for individual risk factors that might contribute to the occurrence of low back problems [2, 6, 8-10, 12-14, 18, 20, 21]. Seven studies did not appear to explain which statistical approach was used [1, 4, 5, 16, 17, 19, 20].

The definition of low back pain was missing or unclear in many studies. Only seven studies provided a description or definition of back problems [1, 2, 6, 8, 10, 18, 21]. The most frequently reported types of low back problem were: a degeneration of lumbar intervertebral disc (a rupture of the outer casing of an intervertebral disc that allows the soft nucleus of the disc to prolapse and rupture adjacent ligaments or press on a spinal nerve) [1, 2, 6, 7, 10, 11, 16]; sciatica (the result of pressure on the sciatic nerve) [7, 8, 10, 21]. In fourteen studies the type of low back problem was not specified.

The papers report almost no data on vibration exposure. One paper [19] reported r.m.s. frequency-weighted acceleration according to BS 6841 (1987) and the calculation of estimated vibration dose values (i.e. eVDV). In other studies, the main information on the nature of the whole-body vibration

was: type of vehicle [6], duration of driving [1, 2, 8, 9, 12, 13, 15, 18, 21], annual mileage [4, 20] or the profession of drivers [2, 4, 7, 16, 17].

Most of the studies discussed the influence of other factors on the occurrence of low back problems. The most frequently reported influencing factors were individual factors, such as gender [2, 7, 9, 12, 13, 15, 18, 20, 21], age [2, 3, 10, 12, 18, 20, 21], body build (weight, height, etc.) [2, 9, 15, 18, 20, 21], cigarette smoking [2, 3, 5, 6, 9, 12, 14, 15, 20], sport [3, 5, 6, 15] and social class and education [2, 9]. A second group of factors reported to influence low back pain were physical factors, such as heavy or repetitive lifting [1, 3-6, 8, 10-15], manual handling [3, 9, 18], bending or twisting [3, 4, 12, 13, 18], sitting [1-3, 8, 12, 13, 15]. The psychosocial risk factors reported to influence low back pain included emotional stress [3, 14, 18], job satisfaction [10, 20], high job demands [12, 13, 18], low social support [9] and job strain [14].

4. Discussion

Twenty-one epidemiological studies of the relationship between exposure to car driving and low back problems have been found. Only four of these studies investigated low back problems among professional drivers. The authors of all other studies selected a sample population from the general public.

Epidemiological studies in this area are difficult and require much time for preparation. There are many potential limitations in such studies, for example the choice of the study population, small sample size, type of question, low response rate, large number of potential associations. Another problem is the inaccuracy in the diagnosis of different types of back problem, which can lead to exclusion of relevant subjects. Most of the studies employed a cross-sectional design. This design can be associated with various sources of bias (e.g. the ‘healthy worker effect’ where people tend to change job when they are adversely affected by the job). Bovenzi and Hulshof (1999) pointed out the occurrence of bias in their literature review due to the selection of studies. The source of this type of bias comes from an incomplete literature search and a bias towards the use of frequently cited publications.

Many of the reviewed studies did not consider vehicular vibration to be the only hazard leading to low back pain. Driving a car involves a specific sitting posture, non-neutral trunk movements, sometimes the lifting of heavy objects, bending, etc. Other individual, physical and psychosocial factors were well considered in most of the reviewed papers. The presence of many other possible factors makes it difficult to define the exact cause of low back problems reported by some car drivers.

It is complex to compare epidemiological studies because there are many differences such as study design, study populations, measures of exposure, risk factors for low back pain and methods of analysis. Bovenzi and Hulshof (1999) in their literature review used a quality rating that allowed them to select the relevant studies. The rating system was based on the presence of important objective criteria such as: assessment of whole-body vibration exposure, assessment of health effects and methodology. Lings and Leboeuf-Yde (2000) also defined a quality criteria rating for their literature review. Their rating was based on the presence of important characteristics (presence of a relevant

control group, description of sampling methods for study and control groups, sufficient response rate, description of vibration dose, definition of the prevalence of low back pain in relation to exposure).

The selection criteria used in previous studies were appropriate for the selected study population but their application in this literature review would exclude most of the published papers.

In this review, all case-control studies [1, 2, 6, 7, 12, 16], both longitudinal studies [9, 11] and almost all cross-sectional studies [4, 5, 8, 10, 13-15, 17-21] concluded that driving a car increased the risk of herniated lumbar intervertebral disc or sciatic pain. This is consistent with the conclusions of the literature review of Bovenzi and Hulshof (1999) who were mainly concerned with environments having high levels of whole-body vibration. However, Lings and Leboeuf-Yde (2000) stated that on the basis of their review of the literature is was not possible to conclude whether exposure to whole-body vibration alone, or only a combination of whole-body vibration with other factors, is capable of causing low back pain.

5. Conclusion

Almost all of the studies included in this review concluded that there is relationship between low back problems and car driving. However, it cannot be concluded that whole-body vibration is the main cause of low back problems among car drivers because most of the reviewed studies did not provide sufficient quantification of the vibration exposure. When compared with drivers of heavy vehicles, car drivers are not exposed to a high level of vibration but evidently there is still a risk of developing low back problems. New studies of car drivers are needed to clarify the relationship between low back pain and the risk factors leading to these problems in car drivers. The design of future epidemiological studies should take into account some of the difficulties in this type of study, including the need for useful measurements of exposure to whole-body vibration and other factors that may influence low back pain.

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Appendix I

Summary of epidemiological studies

	Author (Year)	Study design	Subject group	Data source	Confounders controlled for
1	**Kelsey (1975)**	Case control study (n=717)	General population	X- rays, Interview	sitting, driving,lifting, pushing and pulling
2	**Kelsey, Hardy (1975)**	Case control study (n=934)	General population	X- rays, Interview	driving, place of residence
3	**Frymoyer *et al.* (1980)**	Cross sectional study (n=3,920)	General population (group with LBP, group without LBP)	Interview	age, occupational risk factors (driving, sitting, lifting, carrying, pushing and pulling, bending, twisting), depression, stressful events, sport, smoking
4	**Buckle *et al.* (1980)**	Pilot study with cross sectional design (n=68)	General population	Interview	driving, lifting
5	**Frymoyer *et al.* (1983)**	Cross sectional study (n=1,221)	General population (patients with no pain, patients with moderate pain, patients with severe pain)	Questionnaire	driving, using of vibration equipment, age, lifting, smoking, sport
6	**Kelsey *et al.* (1984)**	Case control study (n=566)	General population (patients with acute prolapsed intervertebral disc)	X- rays, Interview	age, driving (type and age of vehicles), smoking, lifting
7	**Heliövaara (1987)**	Case control study (n=2,732)	General population	Questionnaire	driving, occupational tasks
8	**Walsh *et al.* (1989)**	Cross sectional study (n=545)	General population	Questionniare	lifting, sitting, driving
9	**Pietri *et al.* (1992)**	Cross sectional study (first year) Cohort study (second year) (n=1,719)	Commercial travellers	Medical examination, Interview	sociodemographic factors (age, education, weight, height, etc.), life-style factors (sport, smoking, etc.), work condition (carrying and lifting load, time spent at work, etc.) psychosomatic factors
10	**Masset, Malchaire (1994)**	Cross sectional study (n=618)	Blue collar workers	Questionnaire	prevalence of LBP, driving, heavy effort in job

Summary of epidemiological studies (continued)

	Author (Year)	Study design	Subject group	Data source	Confounders controlled for
11	**Jensen *et al.* (1996)**	Longitudinal study (n=89,146)	Professional drivers	Register information	driving, lifting
12	**Liira *et al.* (1996)**	Case control study (n=31,140)	General population (9 occupational groups)	Interview, Questionnaire	sitting, lifting, bending, vibration, age, smoking
13	**Xu *et al.* (1997)**	Cross sectional study (n=5,185)	General population (11 occupational exposure groups)	Interview	vibration of the whole body, physical hard work, twisting and bending, sitting, standing, walking, heavy lifting, concentration demands, gender, age, years of employment
14	**Barnekow-Bergkvist *et al.* (1998)**	Cross sectional study (n=425)	General population (students)	Questionnaire, Physical measurements	work environmental factors (heavy lifting, vibration, job satisfaction, etc.), psychosocial factors (education, headaches, social class, etc.), individual factors (height, weight, smoking, physical activity, etc.)
15	**Levangie (1999)**	Cross sectional study (n=150)	General population	Questionnaire	driving, vibration, standing, sitting, lifting, smoking, BMI, activity level, vaginal delivery
16	**Videman *et al.* (2000)**	Case control study	Rally drivers (n=18)	Interview, Scaning of spinal imges	driving
17	**Mansfield, Marshal (2001)**	Cross sectional study (n=90)	Rally drivers (40 drivers, 45 co-drivers, 5 drivers & co-drivers)	Questionnaire	muskuloskeletal problems caused by WBV and HTV
18	**Ozguler *et al.* (2000)**	Cross-sectional study (n= 725)	General population (4 occupational groups)	Questionnaire	age, gender, BMI, driving, carrying of heavy loads, bending, psychosomatic factors
19	**Palmer *et al.* (2002)**	National survey Cross sectional study (n=22,194)	General population	Questionnaire	exposure to WBV (occupational sources)
20	**Porter, Gyi (2002)**	Cross sectional study (n=600)	General population	Interview	driving, sitting, standing, adjustability of the car
21	**Tubach *et al.* (2004)**	Cross sectional study (n=3,164)	Electricity and gas company workers	Questionnaire	personal factors (gender, age, height, weight, smoking, etc) physical workload (standing, driving, lifting, etc.) medical factors, psychological and psychosocial factors