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Occupational causes of low-back pain

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WALSH K, VARNES N, OSMOND C, STYLES R, COGGON D. Occupational causes of low-back pain. *Scand J Work Environ Health* 1989;15:54–59. Associations between occupational activities and low-back pain (LBP) were examined in a retrospective postal survey of 545 randomly selected adults. Each subject gave a lifetime occupational history on six specified physical activities and also a lifetime history of LBP. Among the 436 subjects answering the questionnaire, the lifetime incidence of LBP was 63 %. The occurrence of LBP was related by Cox's proportional hazards regression model to occupational activities in the year prior to the onset of symptoms. For the men the strongest associations were with heavy lifting and prolonged car driving. There was also an association with heavy lifting among the women. These risks were exaggerated in the subset of subjects whose LBP followed a chronic unremitting course. The findings are consistent with previous reports linking LBP with manual materials handling and driving at work. However, in this sample, less than 20 % of the cases could be attributed to such activities.

Key terms: driving, lifting, sitting, standing, vibration.

Low-back pain is a common and economically important problem in industrialized societies. It generates substantial demands on medical services and is a major cause of time lost from work (1–3). Most cases of low-back pain in adults of working age are ascribed to degenerative changes in the lumbar spine, but it is unclear whether these changes represent a single disease process or whether a variety of pathogenetic mechanisms independently affects different spinal structures. With the exception of neurological abnormalities of the lower limb due to prolapsed lumbar intervertebral disc, it has so far proved impossible to delineate patterns of symptoms and signs associated with specific pathology of the lumbar spine (4).

Mechanical stresses on the spine, in particular as a result of occupational activities, are widely believed to cause low-back pain, but their impact is hard to assess epidemiologically. Cross-sectional surveys of industrial groups may underestimate the contribution of mechanical factors because subjects with severe low-back pain have been selected out of the most physically demanding jobs. On the other hand, studies which ascertain cases through sickness absence or presentation to a doctor will tend to exaggerate the effects of occupation since subjects with physically demanding jobs are more handicapped by a given level of symptoms and are therefore more likely to take time off work and seek medical advice.

We have attempted to overcome these difficulties by obtaining lifetime histories of low-back pain from

a general population sample and relating the incidence of low-back pain to occupational activities prior to the onset of symptoms. We have also explored the possibility that the syndrome of low-back pain encompasses several etiologically distinct diseases by examining sub-categories of low-back pain distinguished by the time course and radiation of pain.

Materials and methods

The survey was carried out in Whitchurch, a small market town in the south of England where the main sources of employment are agriculture, a paper mill, a silk mill, and service industries. A postal questionnaire was sent to a sample of 267 men and 268 women who were in the age range of 20–70 years and who were selected at random from the list of the local general practice. The subjects were asked to give a lifetime occupational history and to indicate for each job their age at its start and finish and whether an average work-day entailed standing or walking for more than 2 h; sitting for more than 2 h; driving a car or van for more than 4 h; driving a truck, tractor or digger; lifting or moving weights of 25 kg or more by hand; or using handheld vibrating machinery such as chain saws or pneumatic drills.

A history of back pain was elicited with the aid of a diagram outlining the area between the lower costal margins and gluteal folds. The subjects were asked whether they had ever had pain that lasted for more than a day in this area.

Those who had were asked at what age their symptoms began; whether they first came on suddenly or gradually; whether the pain had ever spread down the leg and, if so, to mark on a diagram how far; whether they had suffered from pain for more than a total of

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30 d; what was the longest period that they had been completely free of pain since the onset of their symptoms; and whether they had suffered from low-back pain in the past 12 months. Subjects who reported low-back pain in the past 12 months were asked whether the pain had made it difficult or impossible to walk, get up from an armchair, get out of a bath, get in and out of a car, put on shoes, or go up and down stairs.

Nonresponders were sent two reminders at intervals of six weeks and two months.

The analysis was based upon Cox's proportional hazards regression model (5) with allowance, where appropriate, for time-dependent covariates. As an illustration, when looking at occupational activities at the time of or shortly before the onset of symptoms, we first considered subjects who attained 15 years of age while employed and without a previous history of back pain. This subset of the sample provided information about the risk of first developing back pain at the age of 15 years in relation to occupational activities at the time of the 15th birthday. Information was derived similarly for each year of age up to and including 70 years. The method then combined data from each age group to produce a summary estimate of risk. In one model each activity was examined independently, and in a second all activities were examined simultaneously with the assumption that the risk from a multiple exposure (eg, to both lifting and vibration) was the product of the risk associated with each exposure in isolation.

As well as examining associations with recent occupational activity, we also looked for longer term effects of work. Instead of classifying subjects by occupational activities at the time of their last birthday, we grouped them according to whether or not they had been exposed to activities for more than half their previous worklife. Otherwise the method of analysis was similar, risk estimates being derived for subjects with such exposure relative to those without.

Results

Four hundred and thirty-six questionnaires were returned, giving an overall response rate of 81 % (75 % of the men and 88 % of the women). The response tended to be higher in the older age groups, ranging from 78 % for subjects aged 20–29 years to 89 % for those aged 60 years and over.

The lifetime incidence of symptoms among the subjects who completed the questionnaire is given in table 1. Sixty-four percent of the men and 61 % of the women reported that they had suffered from low-back pain at some time. Subjects who responded to the first mailing reported symptoms more frequently (65 %) than those who only replied to reminders (56 %). Sciatica, defined as pain radiating below the knee, occurred more often in the women (20 %) than in the men (10 %), but the time course of symptoms was similar for both sexes. We excluded from further analysis eight

subjects whose back pain first started before 15 years of age and 11 who could not remember when their symptoms began.

Table 2 shows the risk of low-back pain in successive birth cohorts. At any given age, recent generations tended to report a higher incidence of symptoms than those born earlier. This pattern was observed both for pain of sudden onset and also for pain that came on gradually. To control any confounding effects arising from differences between birth cohorts, subsequent analyses were stratified by year of birth (in 10-year groupings), as well as by age at the onset of symptoms.

Table 3 lists the most common occupations within the study sample and shows the frequency with which different activities were reported in association with these jobs. The distribution of activities conforms with what would be expected from a knowledge of work practices. The apparent anomaly that not all truck and van drivers reported driving trucks arises because light vans are usually classed as cars.

The risks of back pain in relation to occupational activities on the birthday preceding the onset of symptoms are given in table 4. The strongest associations were for lifting and moving weights over 25 kg with relative risks of 2.0 for both the men and the women in the simultaneous analysis of all activities. Car driving also carried an increased risk for the men, but not

Table 1. Lifetime incidence of symptoms.

Symptom	Men (N = 200)		Women (N = 236)	
	Number	%	Number	%
All low-back pain	129	64.5	145	61.4
Low-back pain of sudden onset ^a	64	32.0	62	26.3
Low-back pain of gradual onset ^a	63	31.5	78	33.0
Low-back pain with sciatica	19	9.5	48	20.3
Low-back pain without sciatica	110	55.0	97	41.1
Low-back pain lasting more than a total of 30 d ^a	61	30.5	82	34.7
Low-back pain lasting a total of 30 d or less ^a	62	31.0	62	26.3
Low-back pain with the longest pain-free period lasting more than 30 d ^a	94	47.0	85	36.0
Low-back pain with the longest pain-free period lasting 30 d or less ^a ("unrelenting" pain)	18	9.0	27	11.4

^a Some subjects failed to answer the questions on speed of onset (N = 7), duration of symptoms (N = 7), and longest pain-free interval (N = 50).

Table 2. Relative risk (RR) of reported low-back pain, with 95 % confidence intervals (95 % CI), according to year of birth.

Year of birth	Men		Women	
	RR	95 % CI	RR	95 % CI
1915–1925	1	..	1	..
1926–1935	1.2	0.7–2.2	1.4	0.9–2.4
1936–1945	2.2	1.3–4.0	1.9	1.1–3.2
1946–1955	3.1	1.7–5.7	2.2	1.2–4.1
1956–1965	6.3	3.0–13.2	3.7	1.9–7.6

Table 3. Distribution of occupational activities in the most frequently reported jobs.

Job title	Number of subjects	Number of person-years of exposure	Percentage of person-years positive for occupational activity					
			Walking or standing for more than 2 h/d	Sitting for more than 2 h/d	Lifting or moving weights 25 kg or more	Driving a car for more than 4 h/d	Driving a truck, tractor or digger	Using vibrating machinery
<i>Men</i>								
Clerk	40	509	40	93	8	—	—	—
Agricultural worker	23	275	93	54	99	14	87	42
Soldier	45	267	73	45	33	8	16	—
Paper mill worker	13	225	64	70	72	15	1	1
Truck and van driver	14	126	43	77	89	33	81	10
Motor mechanic	12	123	98	6	72	6	18	6
Shopkeeper	10	122	68	42	43	3	—	—
Carpenter	8	116	100	—	61	14	20	20
Fitter	9	112	96	24	95	5	—	11
Gardener	10	111	95	—	67	30	40	52
<i>Women</i>								
Clerk	107	408	25	87	—	3	—	—
Secretary	43	403	11	97	—	—	—	—
Shop assistant	56	295	100	8	14	—	—	—
Personal care assistant	38	201	77	19	5	—	—	—
Papermill worker	22	141	92	7	23	—	—	—
Paper production worker	11	136	100	—	63	—	—	—
Cleaner	21	115	91	1	16	—	—	14
Agricultural worker	35	111	100	8	35	5	22	8
Teacher	18	96	92	53	—	—	—	—
Hairdresser	8	83	100	—	—	—	—	—

Table 4. Risk of low-back pain by occupational activity on birthday prior to the onset of symptoms.^a (RR = relative risk, 95 % CI = 95 % confidence interval)

Activity	Each activity examined independently				Activities examined simultaneously			
	Men		Women		Men		Women	
	RR	95 % CI	RR	95 % CI	RR	95 % CI	RR	95 % CI
Walking or standing for more than 2 h/d	1.2	0.8–1.8	1.1	0.8–1.6	0.9	0.6–1.4	0.9	0.6–1.4
Sitting for more than 2 h/d	1.3	0.9–1.9	1.2	0.8–1.8	1.3	0.8–2.0	1.3	0.8–1.9
Driving a car for more than 4 h/d	2.1	1.3–3.4	0.7	0.1–4.9	1.7	1.0–2.9	0.4	0.1–3.2
Driving a truck, tractor or digger	1.2	0.7–2.0	1.0	0.1–7.6	0.7	0.4–1.4	0.6	0.1–5.2
Lifting or moving weights of 25 kg or more	1.9	1.3–2.7	1.7	1.1–2.9	2.0	1.3–3.1	2.0	1.1–3.7
Using vibrating machinery	1.5	0.9–2.6	1.4	0.2–10.5	1.3	0.7–2.4	1.1	0.1–9.4

^a For each activity, risks have been calculated for the subjects who reported exposure relative to those who were in work but unexposed.

Table 5. Risk of low-back pain by lifetime occupational activity prior to the onset of symptoms.^a (RR = relative risk, 95 % CI = 95 % confidence interval)

Activity	Each activity examined independently				Activities examined simultaneously			
	Men		Women		Men		Women	
	RR	95 % CI	RR	95 % CI	RR	95 % CI	RR	95 % CI
Walking or standing for more than 2 h/d	1.3	0.9–2.0	0.8	0.6–1.3	1.1	0.7–1.8	0.8	0.5–1.3
Sitting for more than 2 h/d	1.2	0.8–1.8	1.8	1.2–2.6	1.3	0.9–2.0	1.7	1.1–2.6
Driving a car for more than 4 h/d	1.6	0.7–3.5	1.3	0.2–10.0	1.2	0.5–2.8	0.8	0.1–7.1
Driving a lorry, tractor or digger	0.8	0.4–1.4	2.7	0.4–20.1	0.5	0.2–1.0	1.6	0.1–16.6
Lifting or moving weights of 25 kg or more	1.4	1.0–2.1	1.0	0.5–1.9	1.5	1.0–2.4	1.1	0.5–2.4
Using vibrating machinery	1.5	0.8–2.9	7.6	1.7–34.5	1.5	0.7–3.1	5.7	1.1–29.3

^a For each activity, risks have been calculated for the subjects who reported exposure during more than half of their worklife prior to the onset of symptoms relative to those who did not.

Table 6. Associations between subcategories of low-back pain and exposure to vibrating machinery on the birthday prior to the onset of symptoms. (RR = relative risk, 95 % CI = 95 % confidence interval)

Symptom	Men		Women	
	RR	95 % CI	RR	95 % CI
All low-back pain	1.3	0.7–2.4	1.1	0.1–9.4
Low-back pain of gradual onset	2.5	1.1–5.6	0.0	No cases exposed
Low-back pain lasting more than a total of four weeks	3.0	1.3–6.9	2.0	0.2–20.0
Low-back pain associated with sciatica	2.5	0.5–11.7	2.6	0.3–25.6
Unremitting low-back pain	1.3	0.3–5.2	3.3	0.3–41.0

Table 7. Risk of unremitting low-back pain by occupational activity on the birthday prior to the onset of symptoms. (RR = relative risk, 95 % CI = 95 % confidence interval)

Activity	Each activity examined independently				Activities examined simultaneously			
	Men		Women		Men		Women	
	RR	95 % CI	RR	95 % CI	RR	95 % CI	RR	95 % CI
Walking or standing for more than 2 h/d	2.4	0.6–8.9	1.2	0.5–2.8	1.2	0.3–4.7	0.8	0.3–2.3
Sitting for more than 2 h/d	1.6	0.5–5.0	1.8	0.8–4.2	1.8	0.5–6.3	2.0	0.8–4.7
Driving a car for more than 4 h/d	3.2	1.1–9.9	0.0	No cases exposed	2.2	0.6–8.1	0.0	No cases exposed
Driving a truck, tractor or digger	3.4	1.2–9.3	2.8	0.4–21.9	1.4	0.4–5.1	1.1	0.1–13.2
Lifting or moving weights of 25 kg or more	6.5	2.0–21.0	2.5	0.9–6.6	5.3	1.3–20.9	2.9	0.8–10.2
Using vibrating machinery	3.3	1.0–10.7	6.8	0.8–58.8	1.3	0.3–5.2	3.3	0.3–41.0

for the women. There was a trend towards more back pain in those whose jobs required them to sit for more than 2 h per day, but not to the point of statistical significance at a 5 % level.

Table 5 shows the risks of back pain for long-term exposure to occupational activities. The overall pattern was similar to that for recent activities, but the risks for lifting and car driving were lower. The association with use of vibrating machinery among women (relative risk = 5.7 in the simultaneous analysis) was based on only one exposed case.

We looked at subcategories of back pain to see if there were any differences in their associations with occupational activity. The distinctions between pain of sudden and gradual onset and between pain lasting less than and more than a total of four weeks made little difference, except that associations with vibrating machinery were somewhat stronger for prolonged pain and for pain of gradual onset (table 6). The association with handheld vibrating machinery was also more marked for back pain associated with sciatica, and for men with sciatica the risk associated with car driving disappeared. The most distinctive pattern, however, was seen for unremitting back pain (ie, where the longest pain-free interval was less than 30 d) (table 7). In this subcategory the associations described for back pain as a whole were all exaggerated. In particular, the risks for lifting weights over 25 kg went up to 5.3 among the men and 2.9 among the women.

Table 8 shows the levels of disability among the subjects who had suffered from low-back pain during the

Table 8. Levels of disability among the subjects with low-back pain during the past 12 months according to their employment on the birthday prior to the onset of symptoms.^a

Activity	Persons in jobs that entailed lifting or moving weights of 25 kg or more		Persons in jobs that did not entail lifting or moving weights of 25 kg or more	
	N	%	N	%
Walking				
No difficulty	36	58	45	58
Possible with difficulty	23	37	29	38
Impossible	2	3	—	0
Not applicable	1	2	3	4
Getting up from an armchair				
No difficulty	18	29	29	38
Possible with difficulty	43	69	47	61
Impossible	1	2	1	1
Getting out of a bath				
No difficulty	32	52	39	51
Possible with difficulty	25	40	35	45
Impossible	3	5	—	0
Not applicable	2	3	3	4
Getting in and out of a car				
No difficulty	26	42	37	48
Possible with difficulty	34	55	40	52
Impossible	1	2	—	0
Not applicable	1	2	—	0
Putting on shoes				
No difficulty	28	45	42	55
Possible with difficulty	31	50	34	44
Impossible	2	3	1	1
Not applicable	1	2	—	0
Going up and down stairs				
No difficulty	32	52	50	65
Possible with difficulty	25	40	24	31
Impossible	1	2	—	0
Not applicable	4	6	3	4

^a Subjects without employment have been excluded.

past 12 months, according to their employment on the birthday prior to the first onset of symptoms. Disability was slightly greater among the subjects whose jobs had entailed heavy lifting than among those with other types of work.

Discussion

In this study, cases of low-back pain were ascertained solely on the basis of reported symptoms. With this method the wording of key questions can have a substantial effect on estimates of disease frequency (6). Nevertheless, our finding of a lifetime incidence of low-back pain of 64.5 % is comparable to the rates of 62 % found for residents of Copenhagen aged 30–60 years (7), 69.9 % for men aged 19–54 years in Vermont in the United States (8), and 49 % for women in Göteborg, Sweden (9). Moreover, the precise definition of cases is likely to be less crucial in comparisons of disease rates between occupations than it is for overall estimates of incidence.

Our finding that successive birth cohorts reported the development of low-back pain at any given age with increasing frequency has been described before (10). It is possible that the incidence of low-back pain is rising. Certainly in Great Britain over the past 30 years there has been an increase in sickness absence attributed to low-back pain (11,12) and in rates of consultation with general practitioners for low-back pain (13–15). Alternatively, the phenomenon may be due to deficiencies of recall, older subjects failing to remember remote episodes of low-back pain. To exclude any bias arising from this cohort effect, we allowed for period of birth in our analysis of occupation.

Unfortunately, there was no reliable standard against which we could assess the accuracy of occupational activities reported by our subjects. However, the activities which they described were consistent with the jobs in which they said they worked (table 3), and previous studies have indicated that ability to recall past occupations is generally good (16, 17). The reliability of self-reported occupational activities has been assessed directly by Baty and his colleagues in a study of nurses (18). They found that estimates of time spent sitting and standing or walking agreed closely with those of trained observers, but reports of time spent in other activities, such as kneeling, were less reliable. Our questionnaire required subjects only to dichotomize their exposure to each activity and, as such, should have been more valid. However, it is possible that the crude classification which this response entailed tended to obscure some associations with low-back pain.

The subjects may also have had difficulty in recalling accurately the timing of jobs and the onset of low-back pain. However, the fact that associations of low-back pain with activities in the year preceding the on-

set of symptoms were broadly similar to those with lifetime occupational activity suggests that no serious bias resulted from inaccuracies in the timing of symptoms or job changes.

The strongest occupational associations that we found were with heavy lifting, particularly when the low-back pain was unremitting. One explanation for this finding might be that subjects whose jobs entailed heavy lifting had a lower threshold for reporting symptoms, because the symptoms interfered more with their work. However, the reported levels of disability for everyday tasks, such as getting out of a bath (table 8), do not support this hypothesis. If anything, the individuals whose jobs involved lifting reported higher levels of disability. Nor is it likely that the association with lifting resulted from a response bias, since it was present not only among first-time responders but also among subjects who only replied after a reminder. A similar association has been observed in other studies (19–23), though not consistently (24–26). Possibly the failure to detect an effect in some investigations stems from differences in the definition of lifting. It may only be the handling of heavier weights that is important.

Driving a car for more than 4 h a day was associated with low-back pain in men but not with low-back pain in women. However, the number of women reporting the activity was small, and the confidence intervals around their risk estimate were correspondingly wide. Car driving has previously been reported as a risk factor for lumbar disc prolapse (27). Postulated mechanisms include mechanical stresses on the spine from the sitting posture and from vibration. Exposure to vibration is even greater among tractor and truck drivers, occupations which have frequently been identified as prone to low-back pain (28–31) and prolapsed lumbar disc (27). However, no such risk was apparent in our study. We did find associations with jobs that entailed sitting for more than 2 h a day, but they were weak and not statistically significant, except among women with prolonged exposure. The results of other studies which have looked at the effects of sitting have been inconsistent (19, 20, 28, 32). In comparison with other sedentary occupations, car driving allows little opportunity for changes of posture or intermittent standing. Perhaps it is the continuous nature of postural stresses which causes back pain in drivers.

Of the subcategories of low-back pain which we examined, only unremitting back pain showed clearly distinctive features. This pattern of symptoms is not known to indicate any specific spinal pathology, and it is possible that the higher risks which were found for unremitting pain occurred by chance. However, the observation is worth testing in future studies.

Our data give strong support for a role of regular heavy lifting in the etiology of low-back pain and add weight to the evidence implicating occupational driving as a risk factor. At the same time, however, they suggest that such activities account for only a small

proportion of the total burden of low-back pain in the general population. Our estimates of the fraction of disease attributable to heavy lifting and car driving are 14 and 4 %, respectively. Even if allowance is made for uncertainties in these figures, a substantial proportion of cases remain unexplained.

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