

Radiographically detectable lumbar degenerative changes as risk indicators of back pain

A cross-sectional epidemiologic study of concrete reinforcement workers and house painters

by Hilikka Riihimäki, MD, MSc,¹ Gustav Wickström, MD,² Kari Hänninen, MSc(Eng),³ Tor Mattsson, MD,¹ Pekka Waris, MD,¹ Anders Zitting, MD¹

RIIHIMÄKI H, WICKSTRÖM G, HÄNNINEN K, MATTSSON T, WARIS P, ZITTING A. Radiographically detectable lumbar degenerative changes as risk indicators of back pain: a cross-sectional epidemiologic study of concrete reinforcement workers and house painters. *Scand J Work Environ Health* 1989;15:280–285. The association between radiographically detectable degenerative changes in the lumbar spine and back symptoms was studied, along with the possible effect of occupational work load. The subjects were 216 concrete reinforcement workers and 201 house painters. A questionnaire provided information on work history and earlier back accidents, and a standardized interview produced data on back symptoms. The occurrence of disc space narrowing, anterior and posterior spondylophytes, and end-plate sclerosis was recorded separately for each intervertebral space from lateral lumbar radiographs. Moderate to severe degenerative changes were associated with increased risk of sciatic pain but not with the occurrence of lumbago or nonspecific back pain. The different types of degenerative changes provided no further information. In a multivariate logistic regression analysis degenerative changes and earlier back accidents were significant independent predictors of sciatic pain. When these two variates were allowed for, the effect of occupation was not significant.

Key terms: back accidents, disc space narrowing, end-plate sclerosis, heavy work, sciatic pain, spondylophytes.

Lumbar disc degeneration is considered a major cause of back symptoms (1–3). However, the most common means of obtaining information on the degenerative status of the spine, the conventional radiograph, has been subjected to considerable criticism. It has been reported that only one in 2500 spinal radiographic examinations reveals clinically unsuspected positive findings (1).

Because back pain troubles people of optimal work age, measures have been sought to identify individuals susceptible to back pain in industrial settings. Spinal radiographs have been used for preemployment screening purposes, but this practice has been found unsuitable and unjustified (4–8). The specificity and sensitivity of lumbar radiographs have proved unsatisfactory in detecting symptomatic backs (9, 10). Nevertheless, many studies have shown that back symptoms are related to radiographically detectable degenerative changes of the spine (9–16), but there are also those in which no such relationship was found (17, 18).

In the present study men in two physical occupations, concrete reinforcement work and maintenance house painting, had lumbar spinal radiographs and a history of their back symptoms taken in 1977. Concrete reinforcement work has been shown to burden the back more heavily than house painting (19), but in most other respects workers in these two occupations are comparable and represent stable groups of skilled construction workers with a similar socioeconomic status. Concrete reinforcement workers have been reported to have a higher prevalence of sciatic pain (20), and also a higher prevalence of radiographically detectable lumbar degenerative changes, than house painters (21). The aim of our present study was to ascertain the relation between back symptoms and radiographic signs of lumbar spinal degeneration and to determine whether this relationship is affected by occupational work load.

Subjects and methods

This study was restricted to active male workers, aged 25 to 54 years, who had at least 5 years' experience in their current occupation. All 258 concrete reinforcement workers in these age and seniority categories listed in the regional trade union of Uusimaa Province were enrolled in the study. The reference group comprised 235 house painters who were selected from the register of the painters' local trade union of the Helsinki region of Uusimaa Province. The house painters were

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frequency-matched with the concrete reinforcement workers according to five-year age strata. Two hundred and sixteen concrete reinforcement workers (84 %) and 201 house painters (86 %) participated in the study. The mean age of the concrete reinforcement workers was 37.7 (SD 6.6) years, and that of the painters 38.6 (SD 6.6 years).

The data on work experience, back accidents, and smoking were gathered with a self-administered questionnaire which was checked for completeness by a physiotherapist. The workers were asked to list all previous occupations which they had had for at least a year, and also the number of years in these occupations. On the average, the concrete reinforcement workers reported 9.0 years in other occupations (4.2 years in the construction industry, 4.2 years in agricultural or forest work) and the house painters 3.7 years (0.5 years in the construction industry, 2.2 years in agricultural or forest work). The number of back accidents or strains was asked for the past 12 months and for the time before that separately.

The physiotherapist measured the height and the weight of the workers and conducted a standardized interview concerning back symptoms. The mean height of the concrete reinforcement workers was 174.9 (SD 6.6) cm, and that of the painters 174.1 (SD 6.6) cm. The respective weights of the two groups were 79.3 (SD 11.0) kg and 77.3 (SD 12.2) kg. In this report the symptom data are based on the responses (yes, no) to each part of the following question: During the past 12 months have you had (i) sciatic pain (defined as back pain radiating to a leg), (ii) lumbago (defined as a sudden back pain causing constrained posture of the back), (iii) other backache or pain (here called non-specific back pain)?

Lateral lumbar radiographs were taken. The informed consent of the subjects was obtained before the examination. The subjects stood 1.5 m from the X-ray tube, positioned at the level of the iliac crest. The radiographs were read jointly by two radiologists (TM and AZ) who did not know the age or occupation of the subjects. The occurrence of disc space narrowing, marginal anterior and posterior osteophytes of the vertebral bodies (spondylophytes), and end-plate sclerosis was recorded separately for each of the lumbar intervertebral spaces according to the following four-grade classification: 0=no change, 1=slight change, 2=moderate change, 3=severe change. The grading was based on visual judgment supported by a preselected set of reference films.

The reliability of the classification was evaluated in a pilot study that preceded the final reading of the radiographs. The two radiologists read 50 radiographs independently, and weighted kappa coefficients were calculated to measure the agreement beyond chance between the two raters. The coefficients varied between 0.42 and 0.85 for disc-space narrowing in different intervertebral spaces, 0.45 and 0.88 for anterior spondylophytes, 0.23 and 0.56 for posterior spondylo-

phytes, and 0.46 and 0.80 for end-plate sclerosis. Thus the agreement was satisfactory, except for posterior spondylophytes, which were, on the other hand, detected the most infrequently (the prevalence being 18 % for the concrete reinforcement workers and 14 % for the painters).

In the following text, when the findings are described for the entire lumbar spine (L1-S1), disc space narrowing, spondylophytosis, and end-plate sclerosis are given the maximal grade of their occurrence; no distinction is made between anterior and posterior spondylophytes. The grade for the general occurrence of degenerative changes ("all degenerative changes") in the lumbar spine is the maximum of the grades for the three items.

The ordinary chi-square test and the Mantel-Haenszel procedure (22) were used in the statistical testing of the frequency data.

The relation between radiographically detectable degenerative changes and sciatic pain was further investigated with multivariate logistic regression modeling according to the GLIM3 program (23) supplemented with a macro introduced by Wacholder (24); the macro allows the calculation of the estimates of risk ratios (RR) and their 95 % confidence intervals (95 % CI) from the regression coefficients and their standard errors. The dependent variable was the 12-month prevalence of sciatic pain. Modeling was carried out with indicator variables for degenerative changes (grade 0, grade 1, grade 2-3) and covariates [occupation (house painting, concrete reinforcement work); reported earlier back accidents (no, yes); age (25-29, 30-34, 35-39, 40-44, 45-49, 50-54 years); height (≤ 169 , 170-179, ≥ 180 cm); body mass index (≤ 23.9 , 24.0-27.9, ≥ 28.0 kg/m²); smoking (nonsmokers, ex-smokers, smokers)]. Multiple disc degeneration has been considered to be related to back symptoms (1), and so the number of narrowed intervertebral spaces (0, 1, 2 or more) was also regarded as a determinant. The number of years in present occupation was at first included in the set of covariates, but because of the high correlation with age the effect of these two variables could not be separated. Thus the number of years in present occupation was excluded from the final modeling, and only occupation was used as the indicator of occupational exposure. First, a saturated model with main effect terms was constructed, after which we tested for the significance of the terms by excluding them from the model one at a time and observing the significance in the change of the model fit. We also looked for significant interactions between the covariates by adding first-degree product terms to the model and testing for their significance. No significant interactions emerged.

Results

The prevalence of grade 1 degenerative changes in the radiographs was similar for the concrete reinforcement

Table 1. Prevalence of radiographically detectable degenerative changes in the lumbar (L1-S1) spine among the concrete reinforcement workers (N = 216) and house painters (N = 201).

Degenerative change	Concrete reinforcement workers (%)	House painters (%)	Statistical significance ^a
Disc space narrowing			
Grade 1	39.4	38.8	P < 0.001
Grade 2—3	27.8	15.4	
Spondylophytes			
Grade 1	34.3	30.9	P < 0.01
Grade 2—3	27.3	18.4	
End-plate sclerosis			
Grade 1	26.4	21.4	P < 0.05
Grade 2—3	11.2	6.0	
All degenerative changes ^b			
Grade 1	42.1	42.8	P < 0.01
Grade 2—3	37.5	25.9	

^a Mantel-Haenszel test.

^b Maximum of the grades for disc space narrowing, spondylophytes, and end-plate sclerosis.

workers and the house painters, but grade 2—3 changes were more common in the former group (table 1).

The relationship between the 12-month prevalence of sciatic pain and the degenerative changes is presented in table 2. Lumbago seemed to occur independently of lumbar degeneration. Nonspecific back pain showed an increasing trend as the severity of degeneration increased, but the trend lacked statistical significance. Sciatic pain was distinctly associated with the degenerative changes. The age-adjusted risk ratios for the three types of degenerative changes of grade 2—3 ranged between 1.6 and 1.8 (table 3). The risk ratio increased to 2.2 (95 % CI 1.4—3.4) when all degenerative changes were combined.

The univariate risk ratios for the covariates included in the multivariate analysis are presented in table 4. Even though height, body mass index, and smoking were not significantly related to sciatic pain, they were

Table 2. Twelve-month prevalence of back symptoms according to radiographically detectable degenerative changes in the lumbar spine among the concrete reinforcement workers and house painters.

Degenerative change	Concrete reinforcement workers				House painters			
	Number of men	Prevalence (%)			Number of men	Prevalence (%)		
		Sciatic pain	Lumbago	Nonspecific back pain		Sciatic pain	Lumbago	Nonspecific back pain
Disc space narrowing								
Grade 0	71	28	14	41	92	20	11	34
Grade 1	85	34	13	46	78	31	9	47
Grade 2—3	60	53	18	55	31	39	26	45
Spondylophytes								
Grade 0	83	24	17	42	102	19	11	37
Grade 1	74	43	15	51	62	31	16	44
Grade 2—3	59	49	12	47	37	43	11	46
End-plate sclerosis								
Grade 0	135	30	13	45	146	23	12	41
Grade 1	57	44	16	53	43	37	12	42
Grade 2—3	24	63	21	42	12	33	25	33
All degenerative changes ^a								
Grade 0	44	21	21	39	63	16	11	30
Grade 1	91	33	12	46	86	27	11	45
Grade 2—3	81	52	15	52	52	40	17	46
Total	216	37	15	47	201	27	12	41

^a Maximum of the grades for disc space narrowing, spondylophytes, and end-plate sclerosis.

Table 3. Relation between radiographically detectable degenerative changes in the lumbar spine and the 12-month prevalence of sciatic pain.

Degenerative change	Crude risk ratio ^a			Age-adjusted risk ratio ^a		
	Grade 0	Grade 1	Grade 2—3	Grade 0	Grade 1	Grade 2—3
Disc space narrowing	1.0 (—)	1.4 (1.0—2.0)	2.1 (1.5—2.9)	1.0 (—)	1.3 (0.9—1.8)	1.8 (1.3—2.6)
Spondylophytes	1.0 (—)	1.8 (1.3—2.5)	2.2 (1.6—3.2)	1.0 (—)	1.6 (1.1—2.4)	1.8 (1.2—2.7)
End-plate sclerosis	1.0 (—)	1.5 (1.1—2.1)	2.0 (1.3—3.0)	1.0 (—)	1.4 (1.0—1.9)	1.6 (1.1—2.4)

^a 95 % confidence interval in parentheses.

included in the models to allow for their potential confounding effect.

The multivariate analysis yielded similar results for the three types of degenerative changes as determinants of sciatic pain separately. When all three were simultaneously included in the model, none of them retained its significance conditionally on the other two, and no evidence emerged that any of them was a more powerful determinant of sciatic pain than the others.

Thus the combined variable of all degenerative changes was taken as the determinant for the final modeling (table 5). Degeneration and earlier back accidents proved to be significant independent determinants of sciatic pain; the risk ratios adjusted for the other covariates were 1.9 (95 % CI 1.2–2.9) for degeneration of grade 2–3 and 1.8 (95 % CI 1.3–2.5) for earlier back accidents. When these two determinants were allowed for, neither occupation nor age retained its significance.

No significant interaction was detected between occupation and degeneration. In order to reassure the nonexistence of a modifying effect by occupation, analogous multivariate logistic regression models were created for the two occupational groups separately; these models yielded similar relations between sciatic pain and degeneration and earlier back accidents.

Twenty-two percent of the concrete reinforcement workers and 13 % of the painters had two or more narrowed intervertebral spaces. The effect of multiple disc space narrowing on the 12-month prevalence of sciatic pain was similar to that of grade 2–3 disc

space narrowing. When both covariates were simultaneously included as determinants in multivariate modeling, neither was significant conditionally on the other, and no significant interaction between the two was detected.

The relations between degenerative changes at different levels of the lumbar spine and the prevalence of sciatic pain are presented in table 6. In the presacral space, disc space narrowing was associated with an increase in the prevalence of sciatic pain (age-adjusted RR 1.6, 95 % CI 1.2–2.1), as well as spondylophytes (age-adjusted RR 1.5, 95 % CI 1.1–2.0) and end-plate sclerosis (age-adjusted RR 1.5, 95 % CI 1.1–2.1). For the L4–L5 space, the associations were weaker for disc space narrowing (age-adjusted RR 1.4, 95 % CI 1.1–1.8) and for spondylophytes (age-adjusted RR 1.3, 95 % CI 1.0–1.7). There was a similar trend also at other levels.

Discussion

Radiographically detectable moderate or severe degenerative changes in the lumbar spine were associated

Table 5. Relation between radiographically detectable degenerative changes in the lumbar spine and the 12-month prevalence of sciatic pain.

Risk ratio	Grade of the degenerative changes ^{a, b}		
	0	1	2–3
Crude	1.0	1.7 (1.1–2.6)	2.7 (1.8–4.0)
Adjusted for age	1.0	1.5 (0.9–2.4)	2.2 (1.4–3.4)
Adjusted for all covariates ^c	1.0	1.4 (0.9–2.2)	1.9 (1.2–2.9)

^a 95 % confidence interval in parentheses.

^b Maximum of the grades for disc space narrowing, spondylophytes, and end-plate sclerosis.

^c Earlier back accidents, occupation, age, height, body mass index, and smoking. Multivariate logistic regression analysis.

Table 4. Risk ratios and 95 % confidence intervals (95 % CI) for the univariate effects of covariates on the 12-month prevalence of sciatic pain.

Covariate	Risk ratio	95 % confidence interval
Occupation		
House painting	1.0	–
Concrete reinforcement work	1.4	1.1–1.9
Earlier back accidents		
No	1.0	–
Yes	2.2	1.6–3.0
Age (years)		
25–29	1.0	–
30–34	4.7	1.4–15.2
35–39	5.1	1.6–16.2
40–44	5.8	2.0–17.2
45–49	6.7	2.4–18.6
50–54	7.6	2.7–21.6
Height (cm)		
≤ 169	1.0	–
170–179	1.2	0.8–1.8
≥ 180	1.4	0.9–2.1
Body mass index (kg/m ²)		
≤ 23.9	1.0	–
24.0–27.9	1.2	0.9–1.7
≥ 28.0	0.9	0.6–1.4
Smoking		
Nonsmokers	1.0	–
Ex-smokers	1.2	0.8–1.8
Smokers	1.1	0.7–1.7

Table 6. The 12-month prevalence of sciatic pain by the radiologically detectable degenerative changes and their location.

Intervertebral space	Disc space narrowing		Spondylophytes		End-plate sclerosis	
	N	%	N	%	N	%
L1–L2						
No change	392	32	355	31	395	32
Change	25	40	62	40	22	45
L2–L3						
No change	397	32	332	30	392	32
Change	20	40	85	44	25	40
L3–L4						
No change	362	31	282	28	382	31
Change	55	38	135	41	35	43
L4–L5						
No change	219	27	286	28	364	31
Change	198	38*	131	43*	53	43
L5–S1						
No change	316	27	345	29	361	29
Change	101	49***	72	49*	56	52**

* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$ (Mantel-Haenszel test).

with an increase in the risk for sciatic pain but not for other types of back pain. Differentiation between various types of degenerative changes provided no further information. This result seems reasonable because back pain radiating to the legs is an indication of neural irritation, often due to structural derangements in the spine, but lumbago or other back pain may arise from soft tissues, ie, muscles or tendons. The fact that degenerative changes, even disc herniations, are not always symptomatic is well established on the basis of both clinical and epidemiologic experience. Possible contributory factors are the localization of the changes in reference to the neural elements and narrowness of the canal or the foramina of the nerve roots, which may be congenital or due to encroachment caused by degeneration (25, 26).

The relationship between sciatic pain and degenerative changes was the strongest in the two lowest intervertebral spaces, which is in accordance with prior experience (27).

In a cross-sectional study, health-based selection is a matter of concern. Age groups older than 55 years were excluded from this study in order to minimize the effect of possible selection bias. Selection among the subjects hardly has a bearing upon the observed relationship between lumbar degeneration and back symptoms, but it might have caused a negative bias in the effect of occupation on this relationship.

Disc degeneration must be fairly advanced before it can be visualized as a narrowed disc space in a plain radiograph (28). In most earlier studies a radiographic diagnosis of disc degeneration has been employed with varying criteria; spondylophytes and disc space narrowing either alone or in different combinations with end-plate sclerosis have been used. However, spondylophytes do not always occur in connection with a degenerated disc, and it seems erroneous to describe spondylophytes without unequivocal disc space narrowing as being representative of disc degeneration (29).

In the interview, sciatic pain and lumbago were given distinct definitions in order to assure a uniform understanding of these concepts by the subjects. The 12-month prevalences of back symptoms were used as outcome variables because recall error tends to be greater for longer periods of observation. In addition, even in a cross-sectional setting, it seemed reasonable to study the role of lumbar degeneration as a predictor for recent symptoms because degeneration is a slowly advancing process.

In a study of miners, manual workers, and office workers Kellgren & Lawrence (13) found, in accordance with this study, that the relation between radiographic changes and back symptoms was much the same in the three groups. The higher occurrence of back pain among miners was concluded to be more closely related to degenerative changes than to the arduous nature of the work, except insofar as the work was responsible for the degeneration. In two Swedish

studies of selected worker groups (11, 12), the following three types of back symptoms were characterized: sciatica, lumbago, and insufficiency. A definite association between back trouble and radiographic disc degeneration was found in both studies, but the three different back symptoms provided no further information. In a Danish sample of the general population of 60-year-olds, L5 (RR 1.5) and L4 (RR 1.8) disc degeneration was associated with an increased risk for 10-year occurrence of low-back pain radiating to the legs. For other low-back pain the associations were weaker [RR 1.0 and 1.2, respectively, as estimated from the data presented by Biering-Sørensen et al (9)].

In this study lumbar degeneration and earlier back accidents had an independent effect on the occurrence of sciatic pain. The data on back accidents were based on self-report. There may be positive bias in the observed association between back symptoms and back accidents because those with back trouble may be more prone than others to recall their past accidents. It is difficult to obtain reliable and accurate data on back accidents, especially retrospectively. In this study no information on the type or severity of the accidents was available. Episodes of back pain arising suddenly during work are likely to become reported as accidents. According to a previous study (30), only some of such events are true accidents, a considerable proportion are nonaccidental injuries, and for some no cause can be attributed. It seems conceivable that the association between sciatic pain and earlier back accidents may reflect the true injurious effects of accidents, but it may also in part reflect the predictive power of prior episodes for the future attacks, as reported by several authors (31–34).

According to our study, plain lumbar radiographs seem to provide valuable information for the occupational epidemiology of back ailments. Radiographically detectable changes are permanent, and their occurrence rates are not affected by subjective experience or motivation, unlike data on symptoms or clinical examination. Of course, exposure to radiation is a matter of concern in epidemiologic studies. In the future, magnetic resonance imaging could offer means with which to study the degenerative process of the discs without known adverse effects on the subjects. At present, its costliness and lack of capacity are factors limiting the use of this method.

Even though lumbar degenerative changes were found to be a risk indicator for sciatic pain, the fact remains that the specificity and sensitivity of radiographic signs of lumbar degeneration in the detection of symptomatic backs are not high enough to justify the use of spinal radiographs for preemployment screening purposes. However, the twofold increase in the risk for sciatic pain among workers with moderate or severe lumbar degenerative changes should warrant measures of secondary prevention to be directed towards such workers in occupational health practice.

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