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Back pain and heavy physical work: a comparative study of concrete reinforcement workers and maintenance house painters

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ABSTRACT In an investigation of the effect of heavy physical work on the back 217 concrete reinforcement workers aged 25–54 and a reference group of 202 house painters of similar age were interviewed about their back symptoms. Data on occupational history, accidents, and leisure time activities were collected with a questionnaire. The cumulative incidence rate of sciatic pain was significantly higher among the reinforcement workers than the painters. As regards the occurrence of lumbago and non-specific back pain, however, the groups were alike. In both occupational groups sciatic pain during the previous 12 months was associated with earlier back accidents (odds ratio 2·8, 95% confidence interval 1·8–4·5). The accident rate of the reinforcement workers was higher than that of the painters, and this difference seemed to explain their higher rate of sciatic pain.

Epidemiological investigations have shown that 60–80% of the people studied have experienced back pain at some time during their life.[1–3] The occurrence rates vary with the age of the population and also with the methods of survey. In the search for the aetiological elements of back symptoms and back diseases interest in factors related to work and the working environment has been keen. Several such factors have been mentioned as increasing back symptoms: heavy physical work, lifting and forceful movements, accidents, motor vehicle driving, prolonged stooping postures, prolonged sitting, frequent bending and twisting, and repetitive work.[4–6] The differences in the rates of back symptoms among occupational groups have, however, proved to be relatively small, and several writers have therefore concluded that, at present, no conclusive evidence supports the role of, for example, heavy physical work in the aetiology of back disorders.[3 5 7]

In many studies a crude classification into heavy and light work on the basis of occupation or the subjective judgment of the workers has been used without verified information about possible back loading factors in the occupations under consideration. In addition, proper attention has rarely been paid to the different health based selective forces acting among workers both at entry into and exit from different occupations.

Concrete reinforcement work places heavy demands on the back.[8] The work consists of the preparation and assembly of steel rods forming a skeleton to reinforce concrete constructions and includes the handling of heavy loads, often on rough and slippery surfaces and working in awkward static postures of considerable duration. In Finland concrete reinforcement work is a special trade. The reinforcement workers are a stable group, due, among other things, to a relatively high level of income.

The first Finnish study on the effect of concrete reinforcement work on the back was carried out in 1972.[9] The results of the investigation remained mainly descriptive, however, because of a lack of a reference group, and conclusions could not be drawn about the possible effects of reinforcement work on the back. In the present study an attempt was made to find a reference group which would share pertinent characteristics, other than work load, with the concrete reinforcement workers; maintenance house painters were selected for this purpose.

The study included an interview on back symptoms, a clinical examination including radiography of the lumbar spine, and a detailed work analysis. In the present paper the results concerning the occurr-

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Table 1 *Number of concrete reinforcement workers and painters by age and experience in current occupation*

Age (years)	*Experience in current occupation (years)*						
	5–9	*10–14*	*15–19*	*20–24*	*25–29*	*30-*	*Total*
Concrete reinforcement workers							
25–29	15	2	—	—	—	—	17
30–34	21	16	4	—	—	—	41
35–39	7	20	15	2	—	—	44
40–44	5	13	11	1	1	1	44
45–49	4	7	18	11	6	0	46
50–54	2	2	5	6	8	2	25
Total	54	60	55	30	15	3	217
Painters							
25–29	9	7	1	—	—	—	17
30–34	1	16	15	—	—	—	32
35–39	0	4	16	14	—	—	34
40–44	0	1	8	26	9	—	44
45–49	1	0	4	10	26	10	51
50–54	0	0	0	3	9	12	24
Total	11	28	44	53	44	22	202

ence of back symptoms in relation to occupation and a history of back accidents are presented.

Materials and methods

SUBJECTS

Concrete reinforcement workers were selected from the register of the Helsinki regional section of the Construction Workers Union as of 31 December 1976. All the men who (*a*) were registered as active concrete reinforcement workers, (*b*) had had at least five years' experience in reinforcement work, and (*c*) were aged 25–54 were enrolled in the study. Of the total of 258 men, 217 (84%) participated.

The reference group comprised maintenance house painters who were listed in the Painters Local Trade Union of Helsinki region as of 31 December 1976. The referents were also to have had at least five years' experience as painters. To control the confounding effect of age, frequency matching was applied according to five year age strata. The reference group comprised 235 male painters, of whom 202 (86%) participated in the study, which was carried out in the winter of 1977–8.

The mean age of the concrete reinforcement workers was 38·6 (SD 6·6) years, and that of the painters 37·7 (SD 6·6) years (table 1). The reinforcement workers had, on average, 14·6 (SD 6·4) years' experience in their present occupation, the painters 20·6 (SD 6·7) years. The concrete reinforcement workers had worked 4·2 years in other occupations in the construction trade and also 4·2 years in agricultural work. For the painters the respective figures were 0·5 and 2·2 years.

The mean height of the reinforcement workers was 174·9 (SD 6·1) cm and their mean weight 79·3 (SD 11·0) kg. For the painters it was 174·1 (SD 6·4) cm and 77·3 (SD 12·2) kg.

METHODS

Data on occupational history, occurrence of recurring back ache, or pain before entry into the present occupation, former and present state of general health, accidents, physical fitness, and leisure time activities were gathered with a self administered questionnaire. The answers were checked by a physiotherapist before a standardised interview concerning symptoms; the interview took place at the same time as the physical examination.

The questions on back pain were as follows:

'Have you had sciatic pain?' (defined on the questionnaire as back pain radiating to the lower limbs).

'Have you had lumbago?' (defined as sudden back pain causing constrained posture of the back).

'Have you had other back ache or pain?' (I have called these symptoms non-specific back pain).

These questions were asked with reference to the subject's lifetime and the 12 months and one month immediately preceding the examination. The only exception was non-specific back pain during the previous month, instead of which the occurrence of fatigue, stiffness, ache, and sharp pain was requested.

STATISTICAL METHODS

To control the confounding effect of age, a stratified analysis was carried out according to the Mantel-Haenszel method for significance testing.[10]

In the analysis of the association of pain with age, occupation, and back accidents a logistic regression analysis was executed using the GLIM3 computer program.[11] Sciatic pain (SCI) was taken as the

response variable and the stimulus variables were occupation (OCC, factor with two levels), back accidents (BACC, factor with two levels), and age in five year intervals (AGE, factor with six levels).

In the analysis the effects of OCC, BACC, and AGE on the proportion $p_{SCI} = n_{SCI}/n$ were studied. For a given proportion p_{SCI} and denominator n, n_{SCI} is binomially distributed with the mean $\hat{\mu}=n\hat{p}$. On the assumption that n_{SCI} is related to the stimulus variables by a logistic link function, the following equation may be written:

$$\log(\hat{\mu}/(n-\hat{\mu}))=b_0+b_1\,(\mathrm{OCC})+b_2\,(\mathrm{AGE})+b_3\,(\mathrm{BACC}).$$

Effectively, a factor with k levels corresponds to $k-1$ indicator variables representing contrast between the jth level of the factor ($j=2, \ldots, k$) and the first level.

GLIM3 calculates the estimates of the coefficients b_i and their standard errors $\mathrm{SE}(b_i)$ for specified models. A measure of the goodness of fit of a model is given by deviance; deviance is asymptotically distributed according to the chi-square distribution.

The significance of improvement in fit after the inclusion of a variable in the model is tested with a calculation of the differences in the deviances and the respective degrees of freedom and reference to the chi-square distribution.

The odds ratio, contrasting the jth level of factor i with the first level, may be calculated by taking the antilog of the estimated coefficient b_{ij}. The approximate 95% confidence interval may be calculated as[12]

$$\exp\{\, b_{ij} \pm 1{\cdot}96\,[\mathrm{SE}(b_{ij})]\,\}.$$

Results

BACK SYMPTOMS

During their lifetime 87% of the concrete reinforcement workers and 77% of the painters had experienced back pain. The 12 month cumulative incidence rate of back pain was 73% among the reinforcement workers and 59% among the painters. Back pain that had occurred before entry into the present occupation was less common among the reinforcement workers (16%) than the painters (25%) ($\chi^2(1)=4{\cdot}12$, $p < 0{\cdot}05$).

The prognostic value of these early symptoms differed in the two occupational groups. In the painters the pre-entry symptoms were associated with sciatic pain during the 12 months immediately preceding the examination ($\chi^2(1)=9{\cdot}45$, $p < 0{\cdot}01$), but this was not the case for the reinforcement workers. The pre-entry back symptoms were not associated with lumbago or non-specific back pain in either group.

Sciatic pain had been more common among the concrete reinforcement workers than the painters (table 2) and this difference became more obvious with increasing time in retrospect. The lifetime cumulative incidence rate of sciatic pain was 51% for the reinforcement workers and 39% for the painters. With only a few exceptions, the age specific rates for sciatic pain were higher among the reinforcement workers than the painters.

The cumulative incidence rates of lumbago were similar in the two occupational groups. For the previous month, the previous 12 months, and the workers' lifetime, 6%, 14%, and 32% of men had had lumbago.

The 12-month cumulative incidence rate of non-specific back pain was 47% in the reinforcement workers and 41% in the painters; for lifetime occurrence the corresponding figures were 63% and 55%. These differences did not reach the level of statistical significance.

During the month immediately preceding the examination fatigue and stiffness of the back had occurred more commonly among the reinforcement workers than the painters, whereas the occurrence of ache and sharp pain had been the same (table 3).

Table 2 *Cumulative incidence rate of sciatic pain among concrete reinforcement workers and painters by age and time*

Age (years)	*No*	*Previous month (%)*	*Previous 12 months (%)*	*Lifetime (%)*
Concrete reinforcement workers				
25–29	17	6	12	18
30–34	41	20	29	46
35–39	44	27	36	50
40–44	44	23	34	46
45–49	46	28	44	63
50–54	25	48	64	72
Total	217	26	37	51
Painters				
25–29	17	0	0	0
30–34	32	22	25	38
35–39	34	15	21	32
40–44	44	27	34	41
45–49	51	22	35	57
50–54	24	21	25	33
Total	202	20	27	39

Table 3 *Back symptoms occurring among concrete reinforcement workers and painters during the month before the examination*

Back symptom	*Concrete reinforcement workers (n = 217) %*	*Painters (n = 202) %*	χ^2_{M-H}	*p*†
Fatigue	51	38	3·94	<0·05
Stiffness	49	35	5·68	<0·05
Ache	38	31	1·67	NS
Sharp pain	27	27	0·002	NS

†NS = Not significant.

BACK ACCIDENTS

The concrete reinforcement workers reported back accidents more often than the painters; 27% of the reinforcement workers and 19% of the painters had had a back accident during the previous 12 months. The 12 month attack rate of reported back accidents was not associated with age or experience in present occupation in either of the occupational groups.

At some time before the previous 12 months, 68% of the reinforcement workers and 45% of the painters had suffered a back accident ($\chi^2(1)=10·96$, $p < 0·001$): 24% of the reinforcement workers and 18% of the painters reported a permanent handicap due to a back accident.

There is a natural immediate association between back accidents and back symptoms; to be recalled, back accidents must have caused pain. In this study I have tried to determine whether earlier back accidents increase the risk of later episodes of back pain. A statistically significant association was found between sciatic pain during the previous 12 months and back accidents having occurred earlier in both the reinforcement workers ($\chi^2(1)=8·65$, $p < 0·005$) and the painters ($\chi^2(1)=12·25$, $p < 0·001$) (table 4). A corresponding association was not found for lumbago or non-specific back pain.

To study the association of sciatic pain with back accidents, and also with occupation, in more detail, logistic regression models were fitted to the data presented in table 4. Age was included in the analysis to control its confounding effect; the results of the fitting of different models are shown in table 5.

The two term additive model including factors AGE and BACC (step 5) gave a good fit on the data; the inclusion of factor OCC into this model did not improve the fit significantly (step 8). The product terms (interaction terms) of the factors also proved to be non-significant. According to this analysis, age and back accidents had an independent effect on the occurrence of sciatic pain. The rate of sciatic pain was not affected by occupation after age and back accidents were accounted for.

Calculated from the regression coefficient (1·03) and its standard error (0·24), the odds ratio measuring the association of sciatic pain with back accidents was 2·80, its approximate 95% confidence interval being 1·77–4·45.

Discussion

VALIDITY OF COMPARISON

For a valid comparison, the reference group should share all the characteristics of the study group relevant to the problem at issue except exposure.[13] The "exposure" in this study was concrete reinforcement work, which represents heavy physical work.

Table 4 *Sciatic pain occurring among concrete reinforcement workers and painters during the 12 months immediately preceding the examination by age and back accidents*

Age (years)	*Back accidents earlier than previous 12 months*	*Occurrence of sciatic pain*	
		*Reinforcement workers** n_{SCI}/n_{TOT}	*Painters** n_{SCI}/n_{TOT}
25–29	No	1/10	0/10
	Yes	1/7	0/10
30–34	No	3/19	3/23
	Yes	9/22	5/9
35–39	No	1/11	2/21
	Yes	15/33	5/13
40–44	No	4/13	6/24
	Yes	11/31	9/20
45–49	No	4/10	5/23
	Yes	16/36	13/28
50–54	No	3/6	3/11
	Yes	13/19	3/13
Total	No	16/69	19/112
	Yes	65/148	35/90

*n_{SCI} = Number with sciatic pain.
n_{TOT} = Total number in stratum.

Table 5 *Analysis of deviance table derived by fitting logistic regression models to the data in table 4*

Step	*Factors in model**	*Deviance*		*Significance tests*			
			df	*From step*	χ^2	*df*	*p*†
1	—	59·7	23	—	—	—	—
2	AGE	38·8	18	1	20·9	5	<0·001
3	BACC	34·6	22	1	25·2	1	<0·001
4	OCC	54·3	22	1	5·4	1	<0·025
5	AGE + BACC	18·3	17	2	20·5	1	<0·005
6	AGE + OCC	32·6	17	2	6·2	1	<0·025
7	OCC + BACC	33·2	21	3	1·4	1	NS
8	AGE + BACC + OCC	16·4	16	5	1·9	1	NS

*AGE Age (five years intervals from 25 to 54).
BACC Back accidents earlier than previous 12 months (no/yes).
OCC Occupation (painters/reinforcement workers).
†NS = Not significant.

According to a detailed analysis of back loading factors carried out in connection with this project, reinforcement work places greater demands on the back than maintenance house painting in every major category: posture, load handling, minor accidents, and registered occupational accidents.[14] Nevertheless, the physical loading of maintenance house painters is not excessively low either; painting is also dynamic physical work requiring the workers to be relatively physically fit.

There is one major difference in the general work conditions of these two trades. All reinforcement work is done outdoors or, at most, under a temporary cover, whereas maintenance painting is mainly done indoors. Available evidence, however, suggests that climate has little effect on the incidence of musculoskeletal diseases.[6 15]

Owing to the difference in the physical demands of these two trades, a health based selection of workers might be expected to have been stronger among the reinforcement workers than the painters. The inquiry on back symptoms before entry into the trade suported this assumption. Fewer reinforcement workers than painters had back symptoms before entering their present occupation. The reinforcement workers' early symptoms also seemed to be less severe than those of the painters when measured by the occurrence of back symptoms later in life.

Change of occupation is probably not common among skilled construction workers, but, according to the invalidity pension statistics of the Employment Pension Fund, premature retirement due to back diseases is more common among reinforcement workers than among house painters. To reduce the effect of this selection bias, in this study, the men's age was restricted to a maximum of 54, as premature retiring is less common at younger ages.

A minimum requirement of five years was set for the years worked in the present occupation. Back diseases of occupational origin are not likely to occur within a shorter period of exposure, with the possible exception of back injuries caused by accidents. The aim of this restriction was to avoid dilution of the effect under study. On the other hand, some negative bias may have influenced the results—that is, if selection affected the reinforcement workers more than the painters during the first years in the trade.

In the analysis of the interview data inaccuracy of memory is a fact to consider. Because of the same level of basic education, the same compensation policies in case of short term or long term disabilities, and work requiring the workers to be in good physical condition, the reinforcement workers and the painters were not likely to differ in their proneness to remember their back symptoms or back accidents.

The socioeconomic status of the reinforcement workers and the maintenance house painters is also similar; this similarity has strong implications for lifestyle factors, and there is good reason to suppose that the recreational and leisure time activities of the two occupational groups were alike.

Since some of the reinforcement workers under study had also participated in the first study in 1972, the possibility of an intervention effect caused by earlier participation was considered. Two groups were formed from the reinforcement workers in the present study, one comprising the men who had also participated in the 1972 investigation and another of men participating only in the present study and matched to the former group with respect to age and years in the trade. The results obtained for the two groups in the present study were compared, and no evidence of an intervention effect was found.

To summarise, the present comparison of the back symptoms of concrete reinforcement workers with those of maintenance house painters was not unbiased. The magnitude of this bias cannot be estimated, but it seems that the observed differences in the occurrence rates of back symptoms are underestimates rather than overestimates of the true differences.

BACK SYMPTOMS

In most instances back pain is not severe. It has been estimated that in nine out of ten occurrences it is transient and not intense enough to merit a consultation with a doctor.[16] Experience indicates that back pain is episodic and recurrent,[17] but one cannot claim that there is reliable knowledge of the natural history and clinical course of back disorders.

Almost every anatomical structure of the spine and its related tissues have been subject to discussion as a possible source of back pain.[18–20] Pain is indicative of some tissue dysfunction and a disturbance of neurological function. The exact location of the origin of pain in the back is difficult to establish owing to, for example, complex, anastomotic innervation of the spinal tissues.[20] In a great many cases the precise anatomical source of back pain remains undetermined and the diagnosis is correspondingly unsatisfactory.[19 21 22]

This lack of knowledge hampers not only clinical work but also epidemiological studies of back pain. Symptoms described by the general concept of "back pain" are so common in populations that it is merely a matter of course not to detect appreciable differences in the occurrence rates of different populations. It is a difficult task, however, to define back symptoms in such a manner that prognostically significant, more severe cases of back pain can be differentiated from transient, less important symptoms.

Until now no generally accepted standardised questionnaires have been introduced, and the results of different studies are therefore difficult to compare.

In the present study three concepts were used to characterise back pain: sciatic pain, lumbago, and non-specific back pain. Definitions were given for sciatic pain and lumbago to avoid variation in the interpretation of these symptoms by the participants. Even though all back symptoms were more common among the reinforcement workers than the painters, the difference was statistically significant only with regard to sciatic pain.

Sciatic pain, or back pain radiating to the lower limbs, is elicited by the irritation of the lumbar spinal nerve roots or nerve sheaths, but this type of pain may also be provoked by irritation of other deep tissues in the lumbar area.[18 19] Known causes of mechanical nerve root or nerve sheath irritation—that is, the entrapment syndrome—are the protrusion or prolapse of an intervertebral disc, osteophytes of the apophyseal joints, and instability in an intervertebral joint, all sequelae of degenerative processes in the spine.

The opinion that disc degeneration is of importance in the aetiology of back pain is shared by many authors,[1 17 23] but there is no general agreement on this matter.[24]

ACCIDENTS AND BACK SYMPTOMS

In published reports the discussion of the role of trauma as a cause of back pain has concentrated on the immediate relation between the two. The proportion of current attacks of back pain, which have been associated with an accident, heavy lifting, or some unaccustomed activity, varies from 20–30%[17 25 26] to as high as 50%.[22 27]

In the present study it seemed that back accidents that had happened earlier in life increased the risk of sciatic pain. A corresponding association was not found with regard to lumbago or non-specific back pain. The difference in the 12 month cumulative incidence rate of sciatic pain between the reinforcement workers and the painters could be explained by the difference in the accident rates.

The data on back accidents were based on replies to a questionnaire. No questions were asked on the type or severity of the accidents. Therefore, the indicator of back accident history used in this study was crude. Nevertheless, the occurrence rates of back accidents were ascertained by observational work analysis and a short term follow up conducted by telephone interviews of a group of concrete reinforcement workers and maintenance house painters, as well as by a survey of the registered occupational accidents.[14] The results were consistent with those given by the questionnaire.

In the work analysis concrete reinforcement work also differed from painting in respect to other back loading factors: load handling, lifting with back rotated, and stooped postures of long duration. All these back loading factors can cause back pain due to muscular sprains or muscular fatigue. These symptoms are usually transient and of short duration, however. The long term adverse effect of concrete reinforcement work on the back is more likely to be due to the increased risk of repeated injuries, which lead to degenerative changes in the lumbar spine. All the aforementioned back loading factors characteristic of reinforcement work have been described as rendering the back liable to injury.[28–31]

In the present study the excess morbidity of concrete reinforcement workers by comparison with painters was attributable to a higher incidence of sciatic pain. The excess morbidity was associated with a higher risk of back accidents among the concrete reinforcement workers. After adjustment for age and back accidents the role of occupation proved to be non-significant.

The results of this study support the hypothesis that accidents play a major part in the development of degenerative back symptoms. These symptoms

arise after repeated minor or major injuries, which may cause more or less severe, transient back pain, or may even occur without notice. Since the causal relationship between degenerative back symptoms and back injuries remains difficult to prove, there is need for further clinical, experimental, and epidemiological research on this subject.

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