Low Back Pain: Prevalence and Risk Factors in an Industrial Setting

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ABSTRACT. ***Objective.*** To examine various factors associated with low back pain (LBP) in an industrial setting.

Methods. A cross sectional study was carried out among 1562 employees of a large utilities corporation in Ontario using a self-administered questionnaire. Abdominal muscle strength was measured using a modified sphygmomanometer. Statistical analysis was carried out with Student's t test, chi-square test, and logistic regression analysis.

Results. Among 1302 male employees the lifetime and point prevalence of LBP were 60% and 11%, respectively. Low back pain was significantly more prevalent among married employees, with more physically demanding jobs, regular lifting, poor general health, and past major illness. Abdominal muscle weakness was associated with current LBP. The mean time lost from work due to LBP over 5 years was 17 days. Sedentary workers developing LBP were more likely to require hospital admission.

Conclusion. This study confirms the high prevalence of LBP in industry and identifies several risk factors. (J Rheumatol 2001;28:346–51)

Key Indexing Terms:
LOW BACK PAIN INDUSTRY PREVALENCE RISK FACTORS

Low back pain (LBP) continues to be a major health problem and a challenge from the perspective of its high incidence, prevalence, resulting disability, and economic cost. It has been estimated that 60 to 80% of the adult population at one time or another suffers from severe low back symptoms[1]. It is the most commonly cited complaint by patients, the second most common cause of days absent from work, and the most prevalent cause of activity limitation in persons under 45 years of age[2]. In 1978-79, 4.4% of Canadians had serious back trouble, resulting in more than 21 million disability days per year[3].

Studies indicate age, smoking, social economic class, heavy physical work, posture, and level of physical fitness as factors influencing the occurrence of LBP[4-6]. Although lifting results in increased activity of the abdominal muscles and a rise in intraabdominal pressure to support the lumbar spine[7-9], a relationship between abdominal muscle weakness and LBP remains uncertain. To examine various factors associated with the development of LBP in industry, a cross sectional study was carried out in a large cohort of workers employed by Ontario Hydro. In 1985, about 50% of all work absenteeism in this crown corporation was related to LBP (C.C. Lee, personal communication).

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MATERIALS AND METHODS

A study was carried out among workers employed by Ontario Hydro at 3 regional sites (Western Ontario, Eastern Ontario, and Georgian Bay). Among 3000 male employees were linemen, foresters, meter readers, operators, and administrative-clerical staff. Linemen and foresters performed physically demanding tasks, mostly outdoors and with heavy equipment (about 30 pounds around the waist for linemen and heavy duty chainsaws for foresters). Operators and administrative staff worked indoors and performed more sedentary tasks.

Selection criteria. Only men were chosen as they constituted over 90% of employees in this workforce. Male workers between the ages of 23 and 60 years attending a health and safety seminar were invited to participate. Subjects were excluded if there was a history of cardiopulmonary disease, current pain in the abdominal area, or active lesions involving the neck, shoulders, and limbs. Workers with current back pain (while at work) were allowed to participate. Informed consent was obtained in all instances.

A self-administered questionnaire was completed by each subject to obtain information on general health, past major illness or surgery, use of prescribed medication, type of work performed, history of LBP (ever, past 5 years, and at present), symptoms experienced, and work absenteeism. Information was obtained regarding age and marital status. Height and weight were measured and this information was used to calculate the body mass index (BMI).

Definitions. LBP was defined as acute pain in the lower back, below the belt line and above the gluteal sulcus, with or without leg symptoms (numbness, tingling, or pain), and occurring intermittently or continuously over a period of 2 days or longer. Heavy lifting and carrying of heavy objects were defined as lifting or carrying any object weighing ≥ 25 pounds. Regular lifting meant that lifting was a routine part of the job description.

Abdominal muscle strength (AMS) was measured using a modified sphygmomanometer and methods as described and validated[10]. The assessors were 4th year physical therapy students (Western Ontario region) and practising physical therapists (Georgian Bay and Eastern Ontario regions). The cuff from a sphygmomanometer was removed, the exposed bladder folded twice, enclosed in a specially sewn bag and inflated to 20 mm Hg. In the measurement of AMS the subject was required to lie on a plinth so that the back was elevated at an angle of 30° from the horizontal; arms were folded across the chest, knees flexed to 90°, and feet secured under a velcro strap. The subject was then asked to sit up to 45° with a flexed back while the assessor applied pressure through the modified sphygmomanometer cuff against the sternum, just below the sternal notch. The pressure applied was increased gradually to the count of 5 seconds, at which time maximum resistance was obtained. Abdominal muscle strength was recorded in mm Hg.

Statistical methods. Descriptive statistics included mean, median, and standard deviation for continuous variables as well as frequencies and percentages for nominal and discrete variables. Associations with and without LBP were measured with Student's t test for continuous variables, chi-squared test for count variables, and logistic regression analysis. P values are 2 tailed and the level of significance was set at the 5% level; no adjustment was made for multiple testing.

RESULTS

Of 1562 employees screened, 1302 (83.4%) were included in the study. Subjects were excluded (n = 260, 16.6%) for the following reasons: active medical problems that would prevent doing a sit-up maneuver (166, 10.6%), age (< 23 or > 60 years) (n = 76, 4.9%), female sex (n = 16, 1.0%), and other (n = 2, 0.2%). AMS testing was completed in 1266 (97.2%) subjects. In 36 subjects (2.8%) AMS testing was not carried out because of refusal (13), current LBP (20), or problems related to the neck, arms and knees (3).

Of 1302 subjects included in the study, 887 (68.2%) had experienced LBP at some time in the past, 776 (59.6%) had LBP during the previous 5 years, and 145 (11.1%) had LBP at the time of the study. In those with LBP at present, the mean duration was 5.4 (SD 5.9) days. The number of LBP episodes during the previous 5 years varied, with 69.0% reporting 1–5 episodes, 16.0% reporting 6–10, and 15.0% reporting > 10 episodes.

Table 1 shows the age, height, weight, BMI, and AMS and their association with LBP in the study group. Significant associations were present with greater age and current LBP and between greater height and past LBP (ever and during the last 5 years). There was no association between body weight or BMI and the occurrence of LBP.

AMS was not associated with LBP except in those having LBP at the time of the study. A comparison of LBP episodes between younger (23–39 yrs) and older (40–60 yrs) subjects showed no significant differences in prevalence. However, AMS was significantly higher in the younger [277.9 (29.3) mm Hg] compared to older [253.9 (42.0) mm Hg] workers ($t = 11.65$, $p < 0.001$). There were no significant differences in the prevalence of LBP in subjects between different work sites (regions).

The relationship between the occurrence of LBP and marital status is shown in Table 2a. The body habitus of the 2 subsets are compared. The majority of the group were married or had a common-law relationship (88.4%). LBP was significantly more prevalent among married employees (who were also older and heavier, and had a greater BMI). This association between marital status and LBP remained significant after adjusting for height, weight, and BMI (Table 2b). Married personnel had significantly lower AMS compared to single workers.

Table 3 shows the relationship between LBP and type of work done. There were significant differences in the prevalence of previous LBP (ever and previous 5 years) among job types. Previous LBP was highest among linemen, foresters, and those doing shop maintenance work and lowest among meter readers and clerical-management employees.

The jobs of 899 (69.0%) workers required regular lifting and this factor was associated with a higher prevalence of LBP (Table 4). Those doing regular lifting were significantly younger and had greater AMS than those not needing to do this activity. Heavy lifting was associated with a greater overall prevalence of LBP (73.6%) than lifting moderate (69.0%) or light loads (66.7%) or no lifting (64.6%; $p = 0.021$). Workers involved in heavy compared to those doing lighter

Table 1. Age, height, weight, BMI, and abdominal muscle strength (AMS) and the occurrence of low back pain in the study group.

			Low Back Pain (%)					
			Ever		Last 5 yrs		Present	
	n	Mean (SD)	Yes	No	Yes	No	Yes	No
Age, yrs	1302	36.9 (9.1)	37.2	36.3	37.0	36.8	38.4	36.7
p			0.089		0.788		0.039	
Height, cm	1298	178.4 (6.1)	178.8	177.7	178.9	177.8	178.8	178.4
p			0.003		0.003		0.439	
Weight, kg	1295	83.1 (11.1)	83.5	82.3	83.5	82.6	84.8	82.9
p			0.072		0.137		0.057	
BMI, kg/m^2	1294	26.0 (2.7)	26.0	26.0	26.0	26.0	26.2	26.0
p			0.982		0.877		0.347	
AMS, mm Hg			270.8	270.2	272.0	268.7	264.7	271.3
SD			36.0	34.1	35.3	35.5	36.9	35.2
p			0.782		0.128		0.045	

Table 2A. The relationship between marital status, abdominal muscle strength (AMS), and occurrence of low back pain.

	Marital Status		
	Married/Common-law, n = 1144	Single, n = 150	p
AMS, mean (SD), mm Hg	269.7 (35.9)	277.0 (31.1)	0.021
Age, mean (SD), yrs	37.6 (9.0)	31.6 (8.5)	< 0.001
Low back pain, %			
Ever	69.2	60.7	0.034
Last 5 yrs	60.8	51.3	0.026
At present	11.7	6.0	0.036

Table 2B. The effect of marital status on the occurrence of low back pain (LBP) adjusted for height, weight, and body mass index (BMI).

	Height	Weight	BMI
LBP			
Ever	0.032	0.042	0.028
Last 5 yrs	0.023	0.031	0.021
At present	0.043	0.053	0.053

Table 3. The association between low back pain (LBP) and type of work performed (p values from chi-square testing).

	n (%)	Occurrence of LBP, %		
		Ever	Last 5 yrs	At present
Work type				
Shop/maintenance	225 (17.4)	71.1	61.8	9.3
Lineman	482 (37.2)	70.5	63.9	11.0
Forester	162 (12.5)	69.1	58.6	12.4
Clerk/management	347 (26.8)	66.6	56.5	11.6
Laborer	31 (2.4)	58.1	48.4	12.9
Driver/reader	46 (3.6)	45.7	39.1	10.9
Total	1068 (82.5)			
p		0.011	0.009	0.95

Table 4. The prevalence of low back pain among workers whose job required regular lifting.

	Regular Lifting		
	Yes	No	p
Number (%)	899 (69)	401 (31)	
Age, mean (SD), yrs	35.0 (8.5)	41.2 (9.1)	< 0.001
Low back pain			
Ever, %	70.0	64.6	0.054
Last 5 yrs, %	62.2	54.1	0.006
AMS, mean (SD), mm Hg	273.4 (34.6)	264.5 (36.4)	< 0.001

AMS: abdominal muscle strength.

Table 5. The association between current general health status and the prevalence of low back pain.

	N (%)	Low Back Pain, %	
		Ever	Last 5 yrs
General Health			
Excellent	244 (18.8)	59.0	49.2
Good	967 (74.4)	70.1	61.5
Fair	83 (6.4)	73.5	67.5
Poor	5 (0.4)	80.0	80.0
Total	1299 (100)		
p		0.021	< 0.001

lifting were younger [34.9 (8.3) vs 37.3 (9.2) yrs; p = 0.001] and stronger [AMS 277.2 (32.0) vs 269.3 (35.9) mm Hg; p = 0.004]. There was no association between the activities walking, standing, and sitting and the occurrence of LBP.

A significant association was found between past occurrence of LBP and general health status. The prevalence of LBP was lowest among those who perceived themselves as having excellent health and increased stepwise with good, fair, and poor health, respectively (Table 5). Poor general health in the majority (62.5%) was attributed to age, tiredness, smoking, and being "out of shape" or overweight. AMS was not statistically different between employees with excellent/good health [270.9 (35.3) mm Hg] and those with fair/poor [266.2 (37.0) mm Hg] health (p = 0.239).

Three hundred three (23.3%) workers in the cohort had a history of past major illness including surgery. Among these employees, LBP occurred more often (73.6%) than in those with no previous major illness or surgery (66.7%; p = 0.024). There was no significant relationship between current state of general health and a history of previous major illness (p = 0.693). LBP was not more prevalent among those taking prescribed medications.

With logistic regression analysis, significant associations were found between: (1) LBP at present and AMS [OR (95% CI) 1.052 (1.003, 1.104), p = 0.039]; (2) LBP in the previous 5 years and marital status [OR 0.640 (0.449, 0.913), p = 0.014], regular lifting [OR 0.622 (0.475, 0.815), p < 0.001], and height [OR 0.761 (0.629, 0.921), p < 0.005]; and (3) LBP ever and type of work (p = 0.003).

During the preceding 5 years, 46 (5.9%) employees (including 14 linemen and 15 clerical-management staff) experiencing LBP were hospitalized for this problem. The precise reasons for hospital admission were not established. However, only 4.6% of linemen compared to 34.1% of clerical-management workers with LBP required hospital admission for LBP. Hospitalized compared to nonhospitalized employees with LBP were significantly older [41.3 (9.4) vs 36.7 (8.7) years; p < 0.001] and had lower AMS [255.5 (44) vs 273.0 (34) mm Hg; p < 0.001]. Surgery had been recommended to 20 of the hospitalized workers and was carried out in 8 of them.

LBP during the previous 5 year period resulted in lost days from work in 276 (35.7%) employees. The number of days absent from work over this period varied widely [minimum to maximum: 1 to 365, median 6.0, mean 16.8 (33.0) days]. In 17 (2.2%) instances LBP resulted in a job change and in 10 instances this was associated with a decrease in personal income.

DISCUSSION

A cross sectional study of LBP was carried out among male workers employed by a large utilities corporation in Ontario. The men were employed in various capacities related to the generation and transmission of electricity. The study confirms the high prevalence of LBP among working men. Of 1302 subjects studied, two-thirds had at some time in the past experienced LBP and 11.0% of the cohort had LBP at the time of the study. However, this may be an underestimation as 260 of 1562 employees had been excluded from the study because of active health problems (which would have prevented AMS testing). The prevalence of LBP in this subset is not known. Over one-third of the employees surveyed had lost days from work because of LBP.

Studies indicate that more than one-quarter of all working men are affected by LBP each year[11,12]. A point prevalence of 18% was reported among Swedish forestry workers[4]. The reported lifetime prevalence of LBP among men varies between 60 and 80%[13-15]. Sixty percent of Swedish men between the ages 25 and 69 years in the general population were affected and the lifetime prevalence among Swedish industrial and forest workers was 80%[14,15].

We found LBP to be a major cause of loss of days from work and therefore productivity. The mean number of days lost from work (17 days over 5 years), however, is likely conservative because of difficulty with recall. In the 1978-79 Canada Health Survey 4.4% of the population was found to have "serious" back and spine disorders, resulting in a mean of 21 disability days annually[3]. In a population study, 6.7% of those gainfully employed had taken time off during the previous year because of LBP, corresponding to an absence rate of 2 days per year[16]. Among chronic conditions in the United States, impairments of back and spine rank third after heart disease and arthritis and rheumatism (in persons 45 to 64 years) as a cause of activity limitation[2,6]. LBP ranked second to upper respiratory tract infections as a cause of time lost from illness in a New York plant over a 10 year period[17,18].

In our cross sectional study, we examined various demographic and work related factors that might be associated with the development of LBP among the workers in this industry. As found previously, there was no significant difference in the prevalence of LBP between younger and older subjects[19-21]. First episodes of LBP are usually experienced early in life, most often between 20 and 40 years[19,22,23]. Over the age of 65 years, however, the prevalence in men decreases but tends to be more prolonged and disabling[13,24,25].

While workers experiencing LBP in the past were significantly taller than those not experiencing LBP, the differences were small (mean difference 1.1 cm) and are likely of questionable clinical relevance. On a mechanical basis, one might expect LBP to occur more often among tall people and those who are overweight. However, studies have not shown a strong correlation between body build and LBP[4,6]. There were also negative correlations with postural abnormalities and leg length discrepancy. We found no association between body weight and the prevalence of LBP.

Married status has not been recognized as a risk factor for LBP. Previous studies showed that persons who were separated, divorced, or widowed reported back pain more often than those who were currently married or who never married[6,20]. In our study LBP was significantly more prevalent among married employees. The explanation for this observation is not known but could be due to age, psychological stress, lack of physical fitness, or a combination of these factors. Our study indicates that married workers were older and heavier with a higher BMI and mildly weaker abdominal muscles and are likely in poorer physical shape and lack fitness (but cardiovascular fitness testing was not carried out). However, the relationship between marital status and LBP persists even after adjusting for weight and BMI. There is evidence that back strength, AMS, and fitness may protect against back injury[4,26,27] and physical fitness and conditioning of fire fighters resulted in a reduction in frequency of back injuries[26].

Studies have shown a variable relationship between AMS and LBP. An association was found between reduced trunk flexor strength and LBP, but trunk extension appeared to be relatively more weak[28-31]. We did not measure strength of trunk extension, but found AMS to be associated with current LBP. We postulate that either the subjects had sustained a low back injury because of lack of protection from weak abdominal muscles, or alternatively were inhibited from making a strong contraction because of LBP. The observation that reduced flexor strength was correlated with increasing levels of back pain would support the latter[32]. On the other hand, Fairbank, *et al*[33] found that patients experiencing LBP had a greater rise in intraabdominal pressure during lifting. There was a significant correlation between intraabdominal pressure and pain score, suggesting that the greater than expected rise in the former may be a (protective) response to LBP. Apparent differences in findings between the 2 studies might be explained by the fact that there is not always a correlation between AMS and intraabdominal pressure (P. Lee, A. Helewa, unpublished data), or between intraabdominal pressure and trunk electromyographic changes[34]. Obviously the dynamics of lifting, AMS, and intraabdominal pressure is still poorly understood and only a prospective study with serial measurements of strength can determine the association between AMS and the development of LBP.

The occurrence of LBP was significantly associated with the type of work done. In this study the prevalence of LBP was highest among linemen and foresters and lowest among meter readers and clerical-management employees. Furthermore, workers required to lift regularly had a higher prevalence of LBP, which was highest among those doing heavy lifting. It is of interest that the workers involved with regular lifting were significantly younger and had greater AMS compared to those not carrying out this activity. This observation likely is an indication that workers requiring to do regular lifting are more physically fit and stronger, as reflected by their greater AMS.

There is strong evidence linking the occurrence of LBP with heavy work, especially if the activity resulted in sweating[4,6,12]. A Swedish survey showed that disability pensions were more common among men carrying out work with a high physical load[35]. As we found, LBP has been associated with frequent and heavy lifting (of objects weighing > 25 pounds)[6]. Heavy lifting together with twisting and trauma were the most commonly stated causes of LBP[4,6,16,36].

Truck drivers have been found to have among the highest rate of compensable back injuries, with an increased risk for disc lesions[6,36]. Apart from risks associated with loading and unloading trucks, and inadequate back support from poorly designed seats, vibration has been proposed as an additional risk factor among truck and bus drivers[4,6,36]. In our study employees who were designated as drivers did not have an increase in prevalence of LBP. They were meter readers, drove light vehicles relatively short distances, and were not required to lift.

Sedentary jobs may not be as benign as originally thought. Evidence has been put forward indicating an increase in risk with certain activities such as prolonged sitting, stooping, or kneeling[6,25]. The latter might be explained on the basis that intradiscal pressure is higher in the sitting than standing or lying position[37]. Although the prevalence of LBP in our study was lowest among clerical and management employees, this group had the highest hospitalization rate (34.1%) for LBP compared to linemen and foresters (4.6 and 4.3%, respectively). This indicates that when low back injuries occur among sedentary workers they tend to be more severe. Hospitalized workers were also significantly older and had lower AMS, supporting a theory of reduced physical fitness and a risk of sustaining more severe lesions when these workers are injured.

The level of physical fitness in an individual is likely reflected by the perception of their general health status. As might be expected, the prevalence of LBP was lowest among those who perceived themselves as having excellent health. AMS was also highest among these employees. Poor general health in the majority was attributed to the factors such as age, smoking, obesity, and lack of physical fitness. While the lifetime prevalence of LBP was highest among workers with a history of major illness, the latter was not significantly related to the current state of general health. Smoking, found to be a risk factor for LBP and prolapsed disc in the lumbar spine, was not examined in this study[5,6]. Because very few women were employed in this industry, gender issues were not examined. Past studies, however, indicated that men and women have similar risk[6].

Psychosocial factors are recognized as being important in both the reporting and subsequent recovery from LBP. Anxiety, depression, substance abuse, job dissatisfaction, and lower level of education and social adversity may significantly affect the prevalence and outcome of LBP[6,38]. Assessment of psychosocial factors in our study would have been desirable, but was not possible due to time restraints. Only 30 minutes were allocated for testing each subject, some of whom had been brought in from distant locations at significant cost to the employer.

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