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Jean-Pierre Meyer<sup>a</sup>, Dominique Flenghi<sup>b</sup> & Jean-Pierre Deschamps<sup>b</sup>

<sup>a</sup> Institut National de Recherche et Sécurité, France

<sup>b</sup> Université de Nancy 1, France

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## **Effects of Manual Handling, Posture, and Whole Body Vibrations on Low-Back Pain**

**Jean-Pierre Meyer**

Institut National de Recherche et Sécurité, France

**Dominique Flenghi  
Jean-Pierre Deschamps**

Université de Nancy 1, France

To determine the effect of occupational stress on low-back pain (LBP), a cross-sectional study has been carried out, by interviews, on workers exposed to 3 stresses: manual handling (MH, 82 women and 264 men), whole body vibrations (WBV, 274 men), and static postures (278 women). Anthropometric data, occupational stress, LBP severity and frequency, and a psychological evaluation of these groups were compared to those of a control population of 208 workers (104 men and 104 women).

The results show that 30% of the population had never suffered from LBP. Age and the body mass index of the workers were the parameters most closely associated with LBP. Women involved in MH had higher frequency and severity of LBP than their reference population. Men involved in MH or exposed to WBV had higher frequency of painful episodes than their reference population. Workers exposed to one of the stresses were on sick leave for LBP more often, and for longer periods, than workers in the reference group. The results show that individual factors are often decisive in the onset of LBP. Nevertheless, in the more serious LBP cases, occupational stress is an aggravating factor for LBP and its consequences.

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low-back pain   occupation   whole body vibration   posture   manual handling

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Correspondence and requests for reprints should be sent to Jean-Pierre Meyer, Institut National de Recherche et Sécurité, Service de Physiologie Environnementale, Avenue de Bourgogne, B.P. 27, F-54501 Vandoeuvre Cedex, France. E-mail: <meyer@inrs.fr>.

## 1. INTRODUCTION

The first reports on the relationship between working conditions and low-back pain (LBP) date from the mid-nineteenth century during the British railway construction (Allan & Waddell, 1989). Epidemiological studies became frequent after 1950 (Kelsey & White, 1980). All these studies demonstrated that between 60 and 80% of the population has suffered, suffers, or will suffer from LBP during their lifetime (Biering-Sorensen, 1983; Deyo & Tsui-Wu, 1987; Frymoyer et al., 1980). In fact, the prevalence of LBP has not increased since the beginning of the 20th century; it is the repercussions of LBP, expressed in economic terms and disability, that have multiplied tenfold (Allan & Waddell, 1989; Waddell, 1987).

The results of the studies intended to determine the aetiology of LBP are controversial. Indeed, for some of them, there is a significant link between LBP and three types of occupational exposures: manual handling, static postures, and whole body vibration (Andersson, 1984; Damkot, Pope, Lord, & Frymoyer, 1984; Kelsey & White, 1980). However, for other authors, occupational exposure is only a secondary aetiologic factor in the occurrence of LBP (Frymoyer et al., 1980; Pope, 1989). The absence of any indisputable conclusions on risk factors associated with LBP is due to its multi-factorial character (Coste & Paolaggi, 1989; Polatin, Kinney, Gatchel, Lillo, & Mayer, 1993), the difficulty to establish an objective diagnostic and thus a recognised classification of LBP (Coste, Spira, Ducimetiere, & Paolaggi, 1991; Spitzer, LeBlanc, & Dupuis, 1987; Waddell, 1987), and finally the fact that intensity and history of occupational stresses of different workers are difficult to evaluate (Spitzer et al., 1987).

The objective of the present study is to quantify the effects of occupational stress on the severity and frequency of LBP, as well as on the outcomes of LBP in terms of sick leave and medical care. This study was carried out on a population of workers exposed to one of the three occupational risks: manual handling, static postures, or whole body vibrations. These stresses are generally recognised as risk factors for LBP (Andersson, 1984; Biering-Sorensen & Hilden, 1984; Caillard, Czernichow, & Doucet, 1988; Damkot et al., 1984; Kelsey & White, 1980; Riihimäki, Tola, Videman, & Hänninen, 1989). The lumbar pathology of these populations, quantified by the severity and frequency of LBP episodes and their outcomes expressed by sick leave and medical care,

was compared to that of a reference population not occupationally exposed to any of these stresses.

## 2. METHODS

The study was carried out in the form of a cross-sectional and retrospective epidemiological investigation based on interviews with the workers.

### 2.1. Choice of the Study Population

Contacts were made with the occupational physicians of approximately 100 firms where workers were either involved in manual handling operations, or exposed to whole body vibrations, or constrained in static postures for long periods of work. About 50 firms were chosen for participation in the study. These workplaces allowed to use two methods of randomised population choice: either all of the workers in a given exposure, or all of the workers undergoing their annual medical check-up during a single day. At least 20 workers were interviewed at each of the firms. The criteria used to select the population studied were the duration of exposure, which had to be higher than 80% of the working day and the length of exposure, which had to exceed 60% of the total career. The reference population consisted of workers who had never been exposed to any of the aforementioned occupational stresses.

### 2.2. Form and Content of the Interview

All of the interviews were carried out by the same person, who visited the workplaces in order to observe the tasks being performed and to verify the data collected during the interview. The interview was begun after asking the worker if he or she wished to participate in the study and desired information in addition to that displayed in the waiting room. This information gave details on the organisation carrying out the study and the nature, means, and objectives of the investigation. The interview took the form of an oriented discussion, structured in three successive parts on individual, occupational, and clinical data:

1. Individual factors, such as anthropometric parameters, age, tobacco use, familial status, and extra-professional activities (especially sports), were obtained from each participant. The intensity of the extra-professional activities was quantified by means of self-evaluation on a bipolar (none-intensive) scale. Sporting activity was quantified in terms of the type of sport and the number of hours of participation per week. Tobacco use was expressed by the number of cigarettes currently smoked per day. The participants were put into one of four categories: non-smoker, fewer than 5 cigarettes per day, 6-15 cigarettes per day, and more than 15 cigarettes per day.

The questions addressing subjective and psychological aspects were reported on adjective scales. These allowed to collect data on different psychological parameters and in particular on the workers' perception of their "nervous" state or the state of "well-being," both in the workplace and outside of it (Pope, 1989). All the adjective scales contained five levels. For example, in the case of the evaluation of health, the following adjectives were proposed to the workers: very poor, poor, average, good, and very good.

The responses obtained using the bipolar scales were quantified by the distance between the left extremity of the scale and the response marked by the worker. The responses to the adjective scales were encoded from 1 to 5, with the adjective at the left end of the scale always being given the value of 1.

2. Occupational characteristics included the total length of time a worker had ever been exposed to a stress, and both the total number of hours per day and the number of continuous hours of exposure. These parameters were collected for both the current and the past three occupational stresses. Additionally, the workers were asked for the following for each type of constraint: (a) the manual handling workers were asked about the average weight of the loads handled, and the frequency and distance that the loads were carried; (b) workers exposed to whole body vibrations were asked about the type of vehicle, the average distance driven per year, the number of times per day they left their seat; and (c) workers exposed to static postures were asked to describe them. In order to quantify the relative importance of the three types of stress, each worker was asked to indicate the perceived intensity of each of the three stresses on a self-evaluation, bipolar (not at all-solely) scale.

3. The classification of LBP was established using the proposals of Nachemson and Andersson (1982) and Spitzer et al. (1987). In this work, the term severity is used to indicate the maximum level of LBP described by the workers. Severity was broken down into six categories going from no LBP (level 0) to sciatic pain radiating below the knee (level 5). The successive intermediate levels were soreness, pain, lumbago, and sciatica radiating above the knee. The term frequency is used to express the number of painful episodes per unit of time. Frequency was broken down into four levels: single episode, rare (fewer than 1 episode per year), frequent (1–5 episodes per year), and finally a category of more than 5 painful episodes per year, including pain the workers considered to be continuous.

LBP was collected for three periods: the year before the interview, the two years prior to the last year before the interview, and everything up to and including the fourth year before the interview. The severity and frequency of all LBP were quantified for each of these periods.

Finally, LBP was quantified by its outcomes estimated from the amount of sick leave and medical treatment. Medical care was evaluated by whether or not a medical consultation was needed. When the worker had visited a physician, three levels of care were defined: a simple medical consultation, a consultation with a complementary radiological examination, and a consultation with a complementary examination and a prescription of functional therapeutics (physiotherapy or functional rehabilitation). Sick leave was summed over the entire duration of occupational exposure and grouped into one of three categories defined in terms of frequency (a single episode of sick leave, 1–3 episodes, and more than 3), and one of four classifications in terms of average duration (fewer than 7 days, 7–14 days, 15–30 days, and more than 30 days).

### 2.3. Data Analysis

The results were analysed in three steps:

1. The characteristics of the population were quantified by their mean values and standard deviations. Means differences were tested through Student's *t* test for unpaired data. Simple or multiple regressions (Pearson's least squares' method) were used to quantify the relationships between the individual characteristics and LBP. This allowed to take

confounding variables into consideration in the analysis of the occupational stresses on LBP. The differences between the variable distributions were analysed using a chi-squared ( $\chi^2$ ) test.

2. The effects of the occupational stresses on the frequency and severity of LBP were quantified using a  $\chi^2$  test, or a single or multivariate analysis of variance (ANOVA). In the multivariate ANOVA tests, the covariances due to the previously described individual confounding factors were taken into consideration. The transformation of the data into logarithmic co-ordinates was occasionally required to perform these tests.

3. The effects of the occupational stresses on the consequences of LBP expressed by the therapeutics and the amount of sick leave it required were analysed using a  $\chi^2$  test. The results were considered statistically significant at a level of 5% ( $p < .05$ ).

### 3. RESULTS

The anthropometric and clinical data collected for the entire study population will be presented first. Relationships between the individual variables and LBP will be sought in order to define relationships between the occupational stresses and LBP. Finally, the effects of the occupational stresses on the consequences of LBP will be presented in terms of therapy and the number and duration of sick leave.

#### 3.1. Populations Studied

##### 3.1.1. *Physical characteristics*

One thousand, nine hundred and fifty people were interviewed, 1,800 at a work site, and 150 in a preventive medicine center. This latter place was chosen to complete the reference population of individuals who had never been exposed to any of the cited constraints in an occupational environment. After the initial treatment of the interviews and taking the criteria of the stresses (section 2.1.) into consideration, the results of 1,106 workers (208 non-exposed and 898 exposed) were kept for further analysis. Exposure lasting less than 60% of the entire duration of

a career was the most important criterion for exclusion. Fewer than 10 participants refused to participate in the study. The number of women exposed to whole body vibration and the number of men exposed to static postures were too low (fewer than 20 workers) to perform a relevant analysis on the effects of these constraints. In this latter stress, continuous exposure of 2 hrs without rest was requested.

The breakdown of the 1,106 men and women whose results are analysed in this study is presented in Table 1. The averages and standard deviations of age, weight, height, and the body mass index (BMI) are presented in Table 1 for each category of occupational stress.

**TABLE 1. Participants Characteristics. Average and Standard Deviation of Age, Weight, Height, and the Body Mass Index (BMI). Results for Men and Women in the Reference Populations and for the Populations Exposed to Each Occupational Stress. The Number of Participants in Each Population is *n***

Characteristics	Men			Women		
	Reference ( <i>n</i> = 104)	Manual Handling ( <i>n</i> = 264)	Vibrations ( <i>n</i> = 274)	Reference ( <i>n</i> = 104)	Manual Handling ( <i>n</i> = 82)	Posture ( <i>n</i> = 278)
Age (year)	38.2 (9.7)	32.9 (10.1)	38.9 (9.4)	36.3 (9.3)	37.3 (10.6)	36.5 (9.1)
Weight (kg)	75.3 (10.1)	70.5 (10.9)	77.4 (13.3)	58.8 (8.7)	61.9 (12.4)	59.7 (9.8)
Height (cm)	174.5 (6.6)	171.1 (7.1)	171.4 (6.5)	161.1 (5.6)	158.3 (5.1)	159.5 (6.2)
BMI (kg · m <sup>-2</sup> )	24.7 (3.1)	24.1 (3.6)	26.3 (4.0)	22.7 (3.6)	24.8 (5.1)	23.5 (4.0)

From the results in Table 1, one should note the following:

- men involved in manual handling were younger than men in the other categories,
- men exposed to whole body vibration had a higher BMI than men in the other categories,
- women involved in handling operations had a higher BMI than women in the other two populations.

These differences are all statistically significant ( $p < .01$ ). Furthermore, the average length of exposure to the stresses was 13.4 and 14.5 years for men and women, respectively. Men exposed to whole body vibration had an average exposure of 13.8 years, which was significantly ( $p < .05$ )



longer than that of the workers involved in manual handling (12.9 years). Long-distance truck drivers represent 80% of the population subjected to whole body vibration. Finally, men subjected to whole body vibration smoked more often ( $p < .01$ ) and the smokers smoked more (13.3 packets per year) than the smokers in the reference population (6.2 packets per year,  $p < .01$ ).

A socio-economic classification of the different populations shows that the reference population had a semiskilled worker status, and the workers in the populations subjected to a stress were either unskilled or semiskilled.

A comparison of the main occupational constraints done by the participant on the subjective scales on the one hand, and the evaluation by the experimenter through the workplace visit and the data from the interviews on the other hand, shows that the two methods of quantification of stress are in agreement. Nevertheless, in the case of men exposed to whole body vibrations, the method using the self-evaluation scales shows that workers perceive the most important constraint differently. Indeed, for them, the most important stress is whole body vibration. However, they complain about manual handling (37%) almost as much as about whole body vibration (38%) and only a little less about prolonged periods of being seated (25%).

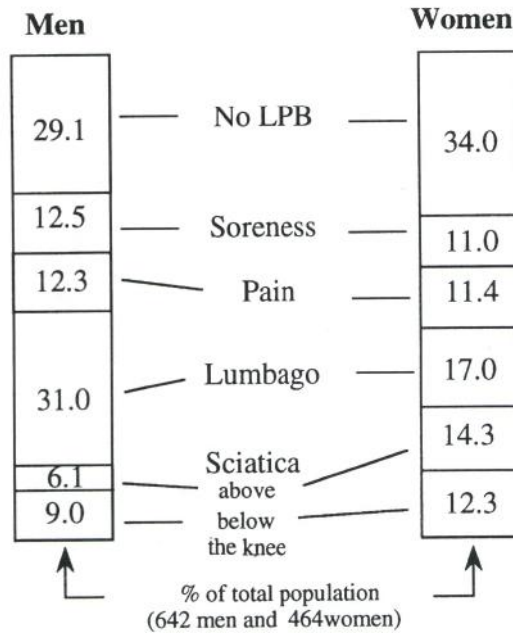
### 3.1.2. *Low-back pain*

Only 29% of the men and 34% of the women included in the entire population—exposed and non-exposed—had never suffered from LBP. The percentages of LBP sufferers were the same for both men and women ( $\chi^2 = 2.7$ ,  $df = 1$ ,  $p = .10$ ).

The percentages of men and women for each level of severity of LBP are shown in Figure 1. In this presentation, the clinical level retained for each worker is the one corresponding to the most severe episode of LBP that he or she reported.

The results in Figure 1 show that men described more episodes of lumbago than women, whereas sciatic pain was more frequently described by women. In the population of LBP sufferers, women seemed to present more serious problems than men ( $\chi^2 = 46.4$ ,  $d = 4$ ,  $p < .01$ ). More than half of the women who suffered from sciatica indicated that it appeared during pregnancy.

The frequency of episodes of LBP is not significantly different for women and men ( $\chi^2 = 2.8$ ,  $d = 3$ ,  $p = .42$ ). Amongst the workers



**Figure 1. Severity of low-back pain. Percentage of men and women in each of the six clinical levels of LBP. Workers suffering from sciatica are classified into two levels of pain radiation, that is, above or below the knee.** Notes: LBP—low-back pain.

suffering from LBP, 8.8% reported one single episode, 62.5% fewer than one episode per year, 20.7% from 1 to 5 episodes annually, and 8% indicated very frequent episodes, some of which were difficult to quantify as they represented continuous pain (section 2.2.). The frequency of episodes of LBP increased at the same time as the severity of the LBP ( $r = .28, n = 726, p < .001$ ).

The subjective evaluations by the workers of their lumbar spine shape is linked to the severity ( $p < .001$ ) and frequency ( $p < .001$ ) of LBP episodes as well as to job satisfaction ( $p < .001$ ). More than half of the workers judged that their lumbar spine was in good or very good shape. A third of them judged that it was in average shape. One out of ten workers said that the lumbar spine was in poor shape and fewer than 2% claimed it was in very bad shape.

### 3.1.3. Individual characteristics and LBP

Because of the differences between the mean ages and anthropometric characteristics of the populations in the three types of stress (Table 1),

the influence of these variables on LBP was analysed first. Then it was possible to test the effect of occupational stresses on LBP by taking into account covariances that might be linked to age, sex, weight, and height.

The severity of LBP increases with the worker's age ( $p < .001$ ); however, the frequency of episodes of LBP is not linked to age. The severity of LBP also increases with the worker's body mass index (BMI;  $r = .17$ ,  $n = 762$ ,  $p < .001$ ). The BMI has no impact on the frequency of LBP episodes ( $p > .3$ ). The results of this study do not indicate any effect of either the height or the weight of the workers on LBP severity or frequency.

Tobacco use is not associated with the severity of LBP; however, both men and women who smoked described more frequent episodes of LBP than did non-smokers ( $r = .13$ ,  $n = 762$ ,  $p < .001$ ).

LBP severity is higher when the perceived intensity of extra-professional activities increases (section 2.2.). This relationship is more significant for men ( $r = .20$ ,  $n = 425$ ,  $p < .001$ ) than for women ( $r = .12$ ,  $n = 289$ ,  $p < .05$ ). On the other hand, physical activities, regardless of their intensity, do not have a significant influence on either the severity of LBP or its frequency.

Men who suffered from LBP claimed they were more "nervous" ( $F_{1,369} = 4.2$ ,  $p < .05$ ), less "at ease" ( $F_{1,374} = 14.9$ ,  $p < .001$ ), and less "satisfied by their work" ( $F_{1,369} = 8.9$ ,  $p < .01$ ) than men who had no LBP. Women suffering from LBP were also more "nervous" ( $F_{4,664} = 15.6$ ,  $p < .001$ ) than those without LBP. The women's answers to questions concerning "at ease" and "satisfied by their work" were similar to those of the men, but showed only a statistical trend ( $p = .08$ ). Some workers were unable to answer the questions presented in the form of self-evaluation scales. This is the reason why the number of answers presented in this section is different from the number of workers involved in the study.

### 3.2. LBP and Occupational Stress

In order to quantify the influence of occupational stresses on LBP, the statistical analyses were performed separately for each sex and they took into account the significant covariances due to age, BMI, and the extra-professional activities of the workers for the severity of LBP, and tobacco use for the frequency of LBP episodes.

### 3.2.1. Severity of LBP

The percentages of workers with and without LBP are shown in Table 2 for both men and women in each of the populations. The percentage of LBP sufferers is indicated for each level of LBP severity. This classification was performed on the basis of the most severe episode of LBP reported by each individual and is used for all the data analysis on LBP severity.

**TABLE 2. Severity of Low-Back Pain (LBP). Percentage of Workers in Each Population Classified According to LBP Severity**

LBP Severity	Men			Women		
	Reference ( <i>n</i> = 104)	Manual Handling ( <i>n</i> = 264)	Vibrations ( <i>n</i> = 274)	Reference ( <i>n</i> = 104)	Manual Handling ( <i>n</i> = 82)	Posture ( <i>n</i> = 278)
No LBP	35.6	28.5	27.3	41.3	20.7	35.1
Soreness	7.7	13.7	13.1	7.7	7.3	13.6
Pain	15.4	13.7	9.8	5.8	19.5	10.0
Lumbago	28.8	30.0	32.4	17.3	17.1	16.5
Sciatica						
above knee	7.7	4.6	7.3	20.2	20.7	11.8
below knee	4.8	9.5	10.1	7.7	14.7	13.3

The breakdown of the workers presented in Table 2 shows that

- the severity of LBP reported by the women of the reference population is not significantly different ( $p > .25$ ) from that of the population of women experiencing prolonged exposures to static postures;
- women involved in manual handling jobs suffered from LBP more often ( $\chi^2 = 9$ ,  $df = 2$ ,  $p < .02$ ), and more severely ( $\chi^2 = 16$ ,  $df = 5$ ,  $p < .01$ ) than women in the two other populations;
- for men, the percentage of those suffering from LBP, and the severity of LBP are not statistically different for each of the three populations. Nevertheless, the frequency of sciatica radiating below the knee is higher for men performing manual handling jobs and for those exposed to whole body vibrations than it is for the reference population. However, the low rate of frequency of this level of severity and the size of the samples mean that this result cannot be interpreted as being statistically significant ( $p = .09$ ).

When the LBP severity reported during the year preceding the interview is considered, LBP of men performing manual handling jobs

or exposed to whole body vibrations is significantly more severe than it is for the reference population ( $F_{2,440} = 4.2, p < .02$ ). The same is true for women in manual handling jobs ( $F_{2,306} = 4.3, p < .02$ ).

One quarter of women attributed the origin of LBP to occupational activities in each of the three populations. On the other hand, 65% of the male handling workers, 42% of the males exposed to whole body vibrations, and fewer than 5% of those in the reference population attributed their back problems to their jobs.

### 3.2.2. Frequency of LBP episodes

The frequency of LBP episodes, broken down into four categories, is shown in Table 3 for the different populations.

**TABLE 3. Frequency of Low-Back Pain (LBP). Percentage of Workers in Each Population Classified According to LBP Frequency**

LBP Frequency	Men			Women		
	Reference ( <i>n</i> = 104)	Manual Handling ( <i>n</i> = 264)	Vibrations ( <i>n</i> = 274)	Reference ( <i>n</i> = 104)	Manual Handling ( <i>n</i> = 82)	Posture ( <i>n</i> = 278)
Single	9.6	7.2	6.2	3.8	9.8	3.2
Rare	45.2	42.2	47.6	38.5	39.0	41.2
Frequent	8.7	17.1	12.0	12.5	18.3	15.4
Continuous	1.0	4.9	6.9	3.8	12.2	5.0

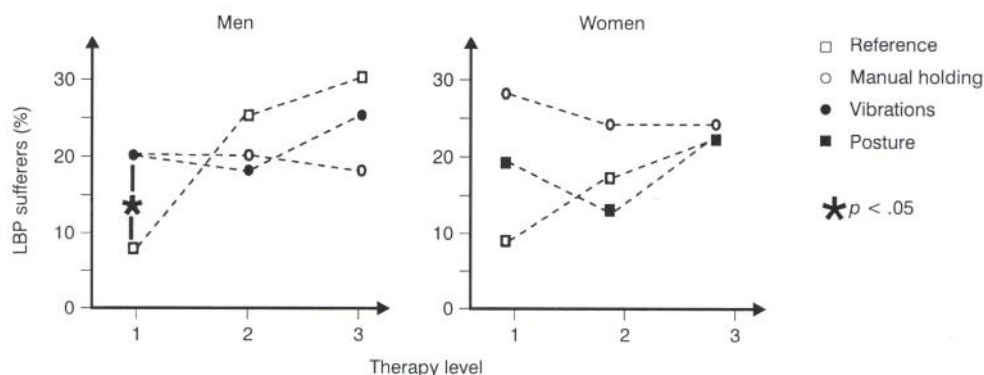
Painful episodes were more frequent for women exposed to manual handling than they were in the reference population or for women exposed to prolonged static postures ( $\chi^2 > 13.3, df = 1, p < .01$ ). Men suffering from LBP and either exposed to vibrations ( $F_{1,264} = 7.8, p < .01$ ) or manual handling ( $F_{1,25^2} = 5.6, p < .02$ ) described more frequent LBP episodes than men in the reference population.

## 3.3. Consequences of LBP and Occupational Stress

### 3.3.1. Medical consultations

Among the entire population of workers suffering from LBP, 37.1% of the men and 42% of the women, had never seen a doctor for their LBP.

The type of consultation chosen by the workers with LBP is shown in Figure 2 for each of the three levels of consultation: (1) a simple medical visit; (2) a medical visit and a radiological screening; and (3) a medical visit, a radiological screening, and rehabilitation treatments from a physiotherapist.



**Figure 2. Medical care. Percentage of LBP sufferers using three levels of care: (1) a simple physician visit, (2) a visit plus a radiological screening, and (3) physiotherapy added to a visit and a radiological screening. Percentages are given for each stress and both genders. Significant differences are indicated with an asterisk. Notes.** LBP—low-back pain.

The results in Figure 2 show that the reference population, for both men and women, benefited from medical care with a radiological screening or rehabilitation treatments more often than workers in manual handling jobs or those exposed to vibrations. This disparity in therapeutics is significant for men ( $\chi^2 = 6.6, df = 2, p < .05$ ), but not for women.

### 3.3.2. Sick leave

Less than one quarter (23.6%) of the entire population studied took sick leave for LBP problems. However, approximately one third of the manual workers (32% of the men and 37% of the women) and of those exposed to vibrations (29.8%) took sick leave because of their LBP problems. Less than 10% of the men in the reference population did so. The percentages of workers in each population taking sick leave are shown in Figure 3 in terms of numbers and in Figure 4 in terms of the length of the sick leaves.

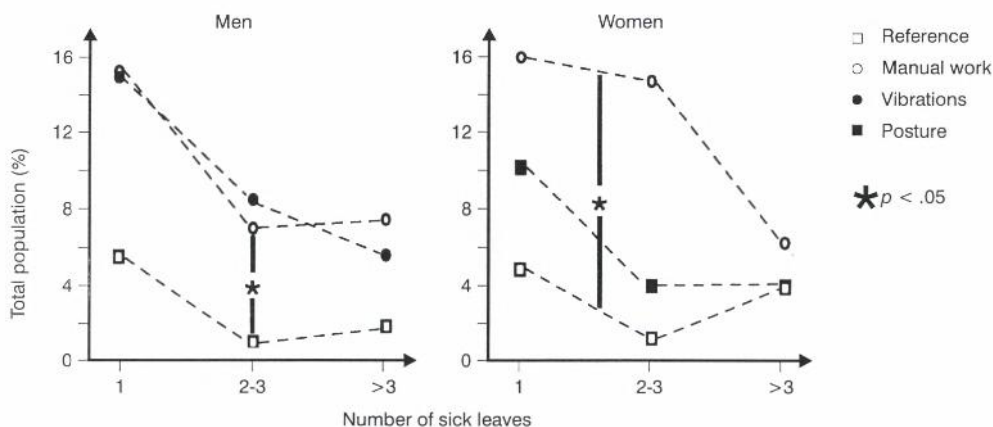


Figure 3. Sick leave. Percentage of workers in each population who took at least 1, 2-3, and more than 3 sick leaves for LBP during their life. Significant differences are indicated with an asterisk.

The number of male workers exposed to a stress, and the number of women in manual handling jobs taking sick leave was significantly higher than in their reference populations ( $\chi^2 > 17$ ,  $df = 2$ ,  $p < .01$ ). Sick leave due to LBP was not statistically higher for women exposed to prolonged static postures than it was for the reference population.

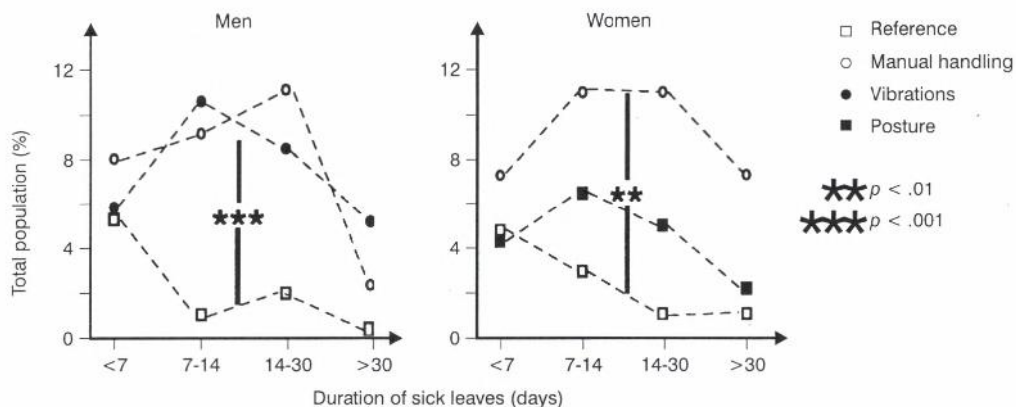


Figure 4. Sick leave. Percentage of men and women with each stress who took sick leaves lasting fewer than 7 days, 7-14 days, 14-30 days, and more than 30 days. Significant differences are indicated with an asterisk.

The length of sick leaves taken by men experiencing different stresses and by women in manual handling jobs was significantly longer than

that of workers in the reference population. The difference was more important for men ( $\chi^2 > 50$ ,  $df = 6$ ,  $p < .001$ ) than for women ( $\chi^2 > 8$ ,  $df = 4$ ,  $p < .01$ ).

In the population of this study, more than one third of all sick leaves was taken by 1.5% of the workers and 62% of this total by 5.6% of them. About 5% of the population studied had 3 or more sick leaves for LBP. All of the workers who took 3 or more sick leaves (5.2% of the total) and almost three quarters of those whose sick leaves lasted for more than 30 days indicated that they suffered from sciatica radiating below the knee.

The subjective evaluation of the shape of the lumbar spine (section 3.1.2.) shows that one man out of ten believed that his spine was in poor shape, whereas two women out of ten were in this category. Finally, less than 2% of the workers believed that their spine was in very poor shape. However, 3.8% of the women in manual handling tasks and 4.7% of the men exposed to whole body vibrations believed their spine to be in very poor shape. The workers subjectively evaluated the level of the different occupational stresses to be higher when the severity ( $p < .001$ ) and frequency ( $p < .02$ ) of the episodes of LBP are higher.

## 4. DISCUSSION

The study methodology, the background of LBP description, the influence of the occupational stresses on LBP, as well as the consequences of LBP will be addressed successively in this section.

### 4.1. Methods

The collection of data in a cross-sectional study presents some drawbacks, the first of which is the healthy-worker effect. The fact that the interviews were conducted on site means that a selection of healthy workers was made as those on sick leave at the time of the study could not be questioned. This healthy-worker effect leads to an underestimation of the disease under study, and in particular of the most serious cases that lead to disability and long sick leave. Thus, the fact that this study does not demonstrate a significant relationship between the occupational stresses and LBP severity cannot exclude this relationship.



The second uncontrollable element in a retrospective study is the difficulty in collecting precise information on events that took place in the past. This difficulty is particular in a morbidity case study, such as the present one on LBP, as an interview cannot obtain precise information on an old LBP episode. The retrospective questionnaire can only partially reconstruct the history of the more severe cases. A precise description of LBP aetiology is only possible when the lumbar problems are examined during the course of a painful episode (Coste et al., 1991; Kelsey & Hardy, 1975). Thus, in order to ensure that the most reliable data were analysed, the only criteria of LBP retained were the most serious case for the severity of LBP and a simple four-level classification for the frequency of LBP. This means of quantifying LBP is more precise than that traditionally used in other studies. Indeed, LBP is defined in the majority of epidemiological studies as an affirmative response to the simple question "Do you have any pain in the lumbar region?" (Deyo & Tsui-Wu, 1987) or, in more precise cases, the participant is asked to indicate the intensity of the pain on a subjective scale (Damkot et al., 1984; Waddell, 1987).

At last, the use of a questionnaire allowed to quantify only the most usual stresses to which the worker was exposed. Unusual components of the stress were not always reported during the course of the interview and they were difficult to code in a questionnaire. The fact that men exposed to a stress attributed the cause of their LBP to occupation more often than did men in the reference group (section 3.2.1.) seems to indicate the importance of these secondary or unusual elements of the stress. Such unforeseen elements, like incidents that need to be compensated for, accidental handling of items, or maintenance, often represent phases of work open to risk. Manual handling, about which a great number of truck drivers complain, is a typical example of an occupational task that is difficult to analyse. In fact, the truck drivers who participated in this study did practically no manual handling at all or did at most a few hours per week of such work. In this case, drivers interviewed here described a large number of factors contributing to a risk of accident during such relatively unusual operations like precipitation, lack of material, reduced working space, and so forth. A detailed analysis of such widely varying elements was impossible in the context of an interview designed for a large population study. The quantification of occupational stresses used in this study did not take uncommon elements of professional activity into account.

Despite such drawbacks, a morbidity study requires the use of a questionnaire. The validity of information collected in this manner has been demonstrated by a large number of retrospective studies (Biering-Sorensen & Hilden, 1984; Damkot et al., 1984). The fact that the questionnaire is completed during the course of an interview means that the data collected are more accurate and complete than those obtained from a questionnaire that the workers complete on their own (Heliövaara et al., 1993). In order to reduce the bias of the cross-sectional questionnaire as much as possible, the information on sick leave that is collected during the interview is compared with that provided by the medical department in the majority of the firms. Such comparisons demonstrated a high level of agreement between both sources of information. Similarly, the occupational constraint described by the workers corresponded to that observed by the interviewer during the course of the visit made to each of the workplaces. The turnover of workers was also monitored in those firms where it was possible to do so. It was very low in all firms, particularly due to LBP.

#### 4.2. LBP in the Entire Study Population

The results of this study were obtained from a population in which 55% of the members (men and women in manual work and men experiencing whole body vibration) were exposed to an occupational constraint that aggravates LBP. Therefore, these results cannot be extrapolated to the general population. Nevertheless, they show that 70% of the workers interviewed had or had had LBP. This percentage is equivalent to that of the reference population, or in the populations exposed to other stress factors. It is also comparable to those described previously (Biering-Sorensen, 1983; Caillard et al., 1988; Frymoyer et al., 1980; Nachemson, 1983).

The results show that on the basis of LBP severity, it is possible to distinguish two groups of LBP. The first group is composed of the least severe pathologies, that is, cases that are not complicated by sciatica with pain going below the knee. This group represents approximately 85% of all cases of LBP (Table 2). The second group is composed of the more severe cases with sciatica radiating below the knee and represents about 15% of the cases of LBP, for which the socio-economic outcomes are significant (section 3.1.2.).

In the first group of LBP, there is no difference of severity of LBP between the reference and study populations. For this reason, the results of this group are applicable to the general population, regardless of occupational activity. It is, therefore, reasonable to consider that 30% of the individuals in the general population did not suffer from LBP, 25% suffered from a limited case of LBP with soreness or a poorly defined pain, and that approximately 35% of all men and 30% of all women suffered from acute pain or sciatica with pain radiating above the knee.

The LBP of the second group is characterised by the presence of sciatica with pain radiating below the knee. The results of this study for this second group cannot be extrapolated to the general population. Hence, this clinical case is over-represented with respect to the entire population in the study because one worker out of ten (9% of the men and 12.3% of the women) had suffered from this LBP severity. However, this level of severity was reported by only 4.8% of the men and 7.7% of the women in the reference population, but by almost 10% of the men and 15% of the women involved in manual handling. Thus, LBP was serious with severe outcomes for "only" 10% of the population. It became worrying for less than 2% of the workers in this study. These workers indicated that their lumbar spine was in poor shape, that they had taken at least 3 sick leaves of more than 30 days, which represented more than a third of all sick leaves taken for LBP reported during this study. These workers must be paid particular attention in terms of both diagnosis and therapy, as well as the conditions of their return to work.

### **4.3. LBP and Individual Factors**

Age and the BMI of the participants are the individual characteristics most closely associated with LBP. The psychological data collected throughout the study also show a relationship between LBP and these parameters. In particular, workers suffering from LBP were more nervous than those without LBP. These results are in agreement with those of a large number of studies that addressed the psychological aspect of lumbar pathologies. These studies show that depressive tendencies can aggravate the manifestation and outcomes of LBP (Allan & Waddell, 1989; Coste et al., 1991; Frymoyer, 1992; Polatin et al., 1993).

#### 4.4. LBP and Occupational Stress

The results of this study showed that women involved in manual handling suffered from LBP more often and with higher severity than did women in the two other groups. The LBP of women exposed to prolonged static postures was no different from that of the women in the reference group. The frequency of LBP episodes was not statistically different in all three female populations. This can be explained by the fact that LBP appeared during pregnancy in more than half of the cases.

The frequency of painful episodes was higher in men exposed to an occupational stress than in the reference population. On the other hand, the percentage of LBP sufferers and the severity of the LBP were not significantly different in the three male populations. Nevertheless, even though this observation is only a tendency (section 3.2.1.), the fact that men exposed to a constraint suffered twice as often from sciatica with pain radiating below the knee than men in the reference population should be underlined. The higher prevalence of sciatica with pain radiating below the knee in a population exposed to whole body vibrations than in an unexposed population has already been described (Kelsey & Hardy, 1975; Riihimäki et al., 1989). The interest of considering this level of lumbar pathology as a threshold of severity has been discussed by Spitzer et al. (1987). Their results, like ours, show that the socio-economic outcomes of LBP, quantified by the number and duration of sick leaves, are more important when LBP is complicated by radiating below-the-knee pain.

Furthermore, in our study, the severity and frequency of LBP reported during the 12 months preceding the interview were significantly higher for workers exposed to manual handling or whole body vibrations than they were in their reference population. This result was obtained from a description of a recent period, which was well in mind and precisely detailed during the course of the interview. If this result was not observed for the previous periods, it could partly be attributed to the difficulty of relating events from a distant past, which is one of the problems associated with retrospective studies (section 4.1.).

Sick leave was significantly more frequent and longer for manual workers and for those exposed to whole body vibrations than for their reference population. The number and duration of sick leaves represent the main social and economic costs of LBP (Frymoyer, 1992; Spengler

et al., 1986). These costs are easier to quantify than are the clinical aspects of LBP and they differentiate the populations subjected to stress from their reference more clearly than LBP. The data collected during the present study show that, for a given level of LBP, the reference population did not take sick leave, whereas manual workers or those exposed to whole body vibrations did. Indeed, manual handling tasks or exposure to whole body vibrations could render a case of LBP intolerable, whereas a job with no physical risk would not induce the worker to take sick leave.

A dose-effect relationship between the intensity of the constraint and the severity of the LBP was not found in this study. This can be explained by the choice of firms and the criteria retained for the populations for each type of stress. An a posteriori analysis of the intensities of the different constraints revealed a very low dispersion. For example, 80% of the women involved in manual handling tasks handled between 7 and 8 hrs per day, and men subjected to whole body vibrations drove on average 8 to 9 hrs per day in almost 80% of the cases. This low dispersion in the levels of stress explains why a dose-effect relationship was not found.

## 5. CONCLUSION

LBP is a frequent pathology, regardless of the occupational stress considered. The percentage of workers who either suffered, or had suffered from LBP found in this study is identical to that previously published. Only a tendency seems to show that serious cases of LBP, characterised by sciatica with pain radiating to below the knee are more frequent in populations exposed to manual handling work or to whole body vibrations than they are in the reference population. Out of these severe cases, there was no difference between the severity of LBP of the reference population and that of the populations exposed to an occupational stress. On the other hand, the frequency of LBP episodes was reported to be higher in the exposed populations. At last, the consequences of LBP expressed by the number and duration of sick leaves due to LBP show that the LBP costs are the stronger indices that differentiate exposed workers from their reference populations. Indeed, the number and duration of sick leaves were much higher for male and female manual workers and for men exposed to whole body vibration than they were in the unexposed populations.

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