Job experience, work load, and risk of musculoskeletal disorders

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Abstract

***Objectives*—To investigate the effects of physical work load and job experience on morbidity from musculoskeletal disorders among trailer assembly workers.**

***Methods*—A longitudinal study was carried out in a trailer assembly factory with many new workers employed during the follow up. The sickness absence of 532 workers (160 experienced and 372 new (separately for the first year of employment and from the second year on)) was followed up. Exposure was assessed by job titles, visits, task descriptions, and some direct measurements. The associations between the explanatory variables and sick leave were assessed by log linear models.**

***Results*—A higher rate of sick leave due to disorders of the upper limbs was found for new workers compared with experienced ones, especially in the high work load group. Women had a higher rate than men. New male workers in physically strenuous tasks had a high rate of sick leave due to neck and shoulder disorders.**

***Conclusions*—As being unaccustomed to work seems to increase the risk of musculoskeletal disorders, special attention should be paid to newly employed workers.**

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Several epidemiological studies have considered the relation between exposure to physical loads at work and musculoskeletal disorders.[1] However, there are limited data on the effects of the duration of exposure to factors of physical load. Long exposure seems to increase the risk of some disorders of the neck and upper limbs,[2–7] and musculoskeletal disorders in general.[8] On the other hand, the duration of employment did not predict sickness absence due to musculoskeletal disorders in a 2 year follow up among male welders and metal workers with at least 12 months of job experience.[9] The effect of the number of years in the job may be difficult to differentiate from those of age, because these two are often correlated. In some studies new workers, or those resuming work after an absence, have been found to be at an increased risk of musculoskeletal disorders, disorders of the upper limbs in particular.[10 11] Few studies have been reported on entry cohorts of workers, however.

Data on sick leaves with medical diagnoses reflect morbidity from disorders and associated disability. Sick leave may be an inaccurate indicator of disease because, as well as the disease itself, many other factors—for example, the social insurance system, the work environment, and other medical, psychological, and social factors—play a part.[12 13] Moreover, seeking medical advice seems to vary according to occupational load.[14 15] Also the practice of prescribing sick leave may vary. Some studies have shown that sickness absence can be considered a relevant indicator of a non-specific health outcome.[16 17] It can be assumed that in manual workers, prescribed sick leave due to musculoskeletal disorders in comparable conditions reflects exposure to physical work load factors.

The aim of this study was to investigate the effects of physical work load and job experience on morbidity from musculoskeletal disorders among trailer assembly workers. The study was carried out in a trailer assembly factory with many new workers employed during the follow up.

Methods

STUDY DESIGN

We carried out a longitudinal study in a dynamic population of assembly workers in a medium sized trailer assembly factory from 1 January 1987 to 30 September 1990. The workers were classified into different categories of job experience according to duration of employment, and their health was followed up through medical records. Exposure to physical work load factors was assessed by job titles, visits, task descriptions, and some direct measurements.

SUBJECTS

The study population consisted of 532 blue collar workers who were selected on the basis of their duration of employment from among 563 workers employed in the factory during the follow up. Workers who had been employed for at least 12 months before the beginning of the follow up were considered to be experienced workers. There were 105 male (mean (SD) age 37.6 (11.3) years) and 55 female (40.2 (8.5) years) assemblers. Complete information on the duration of employment before the follow up was not available, but on the basis of a questionnaire, 31% (n=34) of the experienced workers had had their current work tasks for 1–4 years, and 56% (n=62) for at least 4 years. Due to increased production, altogether 372 workers entered the population during the follow up and were considered to be new workers. This group consisted of 317 male (mean (SD)

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age 25.6 (7.5) years) and 55 female (29.2 (7.9) years) assemblers. They were analysed separately for their first year of employment (new workers, 1st year) and second year onwards (new workers, 2nd+ year). Those who had started the work less than 12 months before the beginning of the follow up (n=31) were excluded from the study. Table 1 presents the accumulation of exposure time for the experienced and new workers during the follow up period.

ASSESSMENT OF EXPOSURE

The trailer assembly factory consisted of seven departments in which parts of trailers, such as walls, roof, floor, and furniture were made. The parts for the furniture were made in the mechanisation department from wooden materials. Some tasks were repetitive hand and wrist movements, and involved static postures of the neck. The walls of the trailers were built in the element construction department where the workers often had to lift heavy loads and to reach far. The tasks in the departments of furniture assembly and fixing were loading for the upper limbs due to frequent driving of screws and drilling with pneumatic hand tools, often with high force demands. A pistol type driver was predominantly used, and ulnarly deviated wrist postures were common, especially when the workers had to reach far.[18] The workers in the mechanisation and element construction department were all men, whereas in the furniture assembly and fixing departments almost all of the workers were women. The tasks in the final assembly, inspection, and transportation department were physically less strenuous, including for example, forklift driving and finishing. Both men and women worked in these tasks. Most workers had individual work stations. Tasks to be completed in a work station were listed in a task card including also task descriptions. The task distribution within a department was designed in a way to keep the variation of the physical work load between the work stations small. Because of this the work load of all the workers, both experienced and new in the same department, was relatively similar. Furthermore, the production rate per worker was fairly stable throughout the follow up.

Based on visits to the departments, task descriptions, and some direct measurements,[18] the tasks of the departments were classified into two categories according to exposure to physical load factors (table 2). The presence of at least two physical load factors was required for the classification of a job as high exposure. The mechanisation, element construction, furniture assembly, and furniture fixing departments were classified as high load jobs.

Data on the work history of each worker were collected from the employer's records. The information included dates for the beginning and end of employment in different departments for all periods of employment during the follow up.

ASSESSMENT OF OUTCOME

Sick leave

The trailer assembly factory had an occupational health service unit of its own with an occupational health physician and an occupational health nurse. The occupational health services consisted of preventive activities and primary medical care. In the case of sick leave, a blue collar worker had to present a medical certificate from the first day of absence, whereas this was not required of the white collar workers for a short sick leave (less than 4 days). This and the few white collar workers were the reasons for excluding them from the study. The diagnoses as well as the days of sick leave were registered in the medical files.

Before being permanently employed in the factory, the worker was employed on probation for 4 months. During this time the worker underwent a medical examination which included questions on previous diseases and symptoms. As a rule, workers reporting a history of work related disorders of the upper limbs were not placed in furniture assembly or in the fixing departments. If a worker contracted an upper limb disorder during his or her probationary period, he or she was placed in less hand intensive tasks or was not employed permanently.

The beginning and ending dates, as well as the diagnoses of sick leave were taken from the medical files. The disorders, all diagnosed by the same doctor, were classified into seven categories:

Table 1 Accumulation of exposure time in trailer assembly by sex, work load, job duration, and age (y)

	Men		*Women*	
Job duration	*Final inspection, transportation (low work load) Person-years (%)*	*Element construction and mechanisation (high work load) Person-years (%)*	*Final inspection, transportation (low work load) Person-years (%)*	*Furniture assembly and fixing (high work load) Person-years (%)*
Experienced workers:				
<30	18 (9)	16 (13)	3 (3)	8 (13)
30–40	49 (24)	33 (27)	22 (21)	19 (31)
>40	134 (67)	75 (60)	78 (76)	35 (56)
All	201 (100)	124 (100)	103 (100)	62 (100)
New workers, year 1:				
<30	47 (71)	54 (79)	5 (45)	15 (65)
30–40	14 (21)	11 (16)	5 (45)	6 (26)
>40	5 (8)	3 (5)	1 (10)	2 (9)
All	66 (100)	68 (100)	11 (100)	23 (100)
New workers, year 2+:				
<30	24 (57)	22 (76)	4 (44)	12 (50)
30–40	10 (24)	5 (17)	4 (44)	5 (21)
>40	8 (19)	2 (7)	1 (12)	7 (29)
All	42 (100)	29 (100)	9 (100)	24 (100)

Table 2 Physical load factors for different body regions by department and the classification of exposure

	Upper limb				*Neck and shoulder*				*Low back*				*All*
	High repetition >2 h	*Forceful exertion >2 h*	*Frequent wrist bending*	*Classification of exposure (high/low)*	*Neck forward flexed >1 h*	*Hands above shoulders >1 h*	*Static posture >2 h*	*Classification of exposure (high/low)*	*Multiple lifting*	*Trunk forward flexed >1 h*	*Vechile transportation >2 h*	*Classification of exposure (high/low)*	*Classification of exposure (total) (high/low)*
Mechanisation	+	−	+	H	+	−	+	H	+	+	−	H	H
Element construction	+	+	−	H	+	−	+	H	+	+	−	H	H
Furniture assembly	+	+	+	H	+	+	+	H	+	+	−	H	H
Furniture fixing	+	+	+	H	+	+	+	H	+	+	−	H	H
Final assembly	−	+	−	L	−	−	−	L	−	−	−	L	L
Final inspection	−	−	−	L	−	−	−	L	−	−	−	L	L
Transportation	−	−	−	L	−	−	+	L	−	−	−	L	L

+=Load factor present; −=load factor not present; H=high work load; L=low work load.

(1) Tenosynovitis or peritendinitis in the wrist or forearm, epicondylitis, and other musculoskeletal disorders in the wrist, forearm, or elbow region
(2) Neck and shoulder disorders
(3) Low back disorders
(4) Other musculoskeletal disorders
(5) Acute respiratory or gastrointestinal infections
(6) Occupational accidents
(7) Other diseases and accidents.

STATISTICAL ANALYSIS

Exposure time was calculated as the time accumulated by a worker to a group defined by work load, job experience, sex, and age. When the worker changed work load category, or job experience category, or reached the upper limit of his or her age group, he or she started to contribute time to another appropriate group. The numbers of days of sick leave due to different disorders were calculated for each worker in each work load, job experience, and age group.

Our outcome variables were the numbers of days of sick leave due to disorders of the upper limbs, neck and shoulders, low back, and other musculoskeletal problems. The explanatory variables were work load, job experience, sex, and age, which were all categorical: work load (two categories), job experience (three categories), sex, and age (three categories). In preliminary analyses we scrutinised the proportions of days of sick leave from exposure time in the different groups according to sex, job experience, and work load. As the number of days of sick leave were counted data, log linear models were used to assess the associations between the explanatory variables and the outcomes. It was assumed that the days of sick leave were directly proportional to exposure time. We took into account the different exposure times by introducing into the log linear models an offset term, $\log(t_i)$, where t_i indicates the exposure time for a worker i. Due to correlated data the generalised estimating equations method (GEE)[19] was used to fit the models. This method ensures consistent parameter estimates and their variances. Because the work load classified as high or low was different for the men and the women, the interaction between work load and sex was our first interest—that is, whether the risk of high load versus low load differed between men and women. To begin with, all explanatory variables and their first order interactions were included in the model. Then the model was fitted again without the least significant term. This backward elimination method was continued until all the remaining terms in the model were significant at 5% level. Statistical analyses were done by the GENMOD procedure in SAS/STAT software.[20]

Results

MORBIDITY FROM MUSCULOSKELETAL DISORDERS

The proportion of days of sick leave during the follow up time is presented in table 3 for all the workers in the factory. Of all working days 6% were lost due to diseases and accidents.

Table 3 Proportion of days of sick leave (% of potential work days) in trailer assembly during the follow up of 3 years and 9 months

Job experience/disorder	Men (530 person years)	Women (232 person years)
Experienced workers (490 person-years):		
Musculoskeletal disorders	2.2	3.3
Infections	0.6	0.9
Occupational accidents	0.6	0.8
Other disorders and accidents	2.0	1.2
All disorders and accidents	5.4	6.2
New workers, year 1 (168 person-years):		
Musculoskeletal disorders	2.3	4.7
Infections	1.1	1.3
Occupational accidents	1.3	0.8
Other disorders and accidents	2.5	3.2
All disorders and accidents	7.2	10.0
New workers, year 2+ (104 person-years):		
Musculoskeletal disorders	2.2	4.8
Infections	1.3	1.7
Occupational accidents	1.5	2.2
Other disorders and accidents	2.6	2.1
All disorders and accidents	7.6	10.8

Musculoskeletal disorders were the largest group of disorders and accounted for 42% of lost days. The proportion of days lost due to musculoskeletal disorders was conspicuously high among women, making up about half of all lost days. Other major causes of sick leave were occupational accidents and infections. Also their proportions were higher among the new workers than among the experienced workers.

During the follow up, 14% (n=73) of the study population had at least one spell of sick leave due to disorders of the upper limbs, 17% (n=91) neck and shoulders, 22% (n=119) low back, and 8% (n=43) other musculoskeletal disorders.

According to preliminary analyses the proportion of days of sick leave due to disorders of the upper limbs and neck varied according to sex, age, work load, and job experience (table 4). The women and the workers with high work load had more absenteeism than the men and the workers with low work load. For all disorders absenteeism was highest among workers aged 30–40 years. The proportion of days of sick leave due to disorders of the upper limbs was 1.6-fold for the new workers during the first year and 2.8-fold for the new workers for the 2nd year onwards compared with the experienced workers.

PREDICTORS OF SICK LEAVE DUE TO MUSCULOSKELETAL DISORDERS

Upper limb disorders

According to the log linear modelling, the rate of sick leave due to disorders of the upper limbs varied in the high and low work load groups according to job experience and sex (table 5). Among both men and women the effect of work load on the rate of sick leave differed according to job experience, being highest in the first year of employment, and lowest for the experienced workers (table 6). During the first year of employment, the rate for men in the high work load group was almost threefold and for women over 10-fold compared with those in low load groups. Furthermore, the effect of work load was higher among women than among men in each job experience category (table 6). Age had also an effect on the rate of sick leave due to disorders of the upper limbs. In the age group of 30–40 years, the rate was threefold compared with that of those under 30 years, whereas among those over 40 years the rate did not differ significantly from that of the young workers (table 5).

The effect of job experience on the rate of disorders of the upper limbs depended on work load. In the high work load group all new workers had a higher rate compared with experienced workers. The rate during the first year of employment was threefold, and from the second year onwards almost fourfold compared with experienced workers. In the low load group the rate of sick leave of the new first year workers was smaller than that of the experienced workers, but from the second year onwards no difference was found between experienced and new workers (table 7). The effect of sex varied by work load as well. The rate of sick leave of women due to disorders of the upper limbs in the high load group was almost fivefold that of the men, whereas in the low load group the rates of men and women did not differ from each other (table 5).

Disorders of the neck and shoulders

The difference between the rates of sick leave due to neck and shoulder disorders for low and high work load depended on job experience. New workers during their first year in the high

Table 4 Proportion of days of sick leave (% of potential work days) in trailer assembly by sex, age, occupation, and job experience during the follow up time of 3 years and 9 months

Explanatory variable	Exposure time (person-years)	Musculoskeletal				
		Upper limb	Neck and shoulder	Low back	Other musculoskeletal	All musculoskeletal
Sex:						
Male	530	0.4	0.5	1.0	0.2	2.1
Female	232	1.3	1.1	0.9	0.3	3.6
Age (y):						
<30	228	0.6	0.7	0.9	0.1	2.3
30–40	183	1.3	1.0	1.2	0.3	3.8
>40	351	0.5	0.5	0.9	0.2	2.1
Work load:						
Low load	432	0.5	0.5	1.1	0.2	2.3
High load	330	1.0	0.9	0.8	0.2	2.9
Job duration:						
Experienced worker	490	0.5	0.6	1.1	0.3	2.5
New worker, year 1	168	0.8	0.6	0.9	0.1	2.4
New worker, year 2+	104	1.4	1.0	0.6	0.1	3.1

Table 5 Factors associated with sick leave due to arm, and neck and shoulder disorders

	Arm disorders			Neck and shoulder disorders		
Predictor	*RR*	*95% CI*	*p Value*	*RR*	*95% CI*	*p Value*
Sex:						
Male	1.0			1.0		
Female	1.3	0.5 to 3.6	0.58	12.8	3.7 to 44.5	0.00
Age (y):						
<30	1.0			1.0		
30–40	2.9	1.2 to 7.1	0.02	3.2	1.2 to 8.6	0.02
>40	1.2	0.5 to 2.9	0.67	1.9	0.6 to 6.3	0.28
Work load:						
Low load	1.0			1.0		
High load	0.5	0.2 to 1.4	0.19	0.9	0.5 to 1.7	0.85
Job experience:						
Experienced worker	1.0			1.0		
New worker, year 1	0.6	0.2 to 1.7	0.31	1.1	0.4 to 2.8	0.90
New worker, year 2+	1.1	0.4 to 3.3	0.83	0.6	0.2 to 2.5	0.52
Sex, age:						
Female, <30				1.0		
Female, 30–40				0.2	0.1 to 0.8	0.02
Female, >40				0.1	0.0 to 0.6	0.01
Sex, job experience:						
Female, experienced worker				1.0		
Female, new worker, year 1				0.3	0.1 to 1.4	0.12
Female, new worker, year 2+				0.1	0.0 to 0.4	0.00
Sex, work load:						
Female, low load	1.0					
Female, high load	3.6	1.0 to 12.7	0.04			
Work load, job exerience:						
High load, experienced worker	1.0			1.0		
High load, new worker, year 1	5.4	1.4 to 20.3	0.01	2.3	0.7 to 7.8	0.17
High load, new worker, year 2+	3.5	0.8 to 15.5	0.10	11.1	2.6 to 47.7	0.00

RR=rate ratios.
p Values calculated by log linear modelling.

work load group had a twofold rate compared with those with low work load. Furthermore, from the second year onwards the rate increased considerably (table 5). Among the experienced workers the rates did not differ between the low and high work load groups.

The effect of age on the rate of sick leave due to neck and shoulder disorders was different for men and women. Men aged over 30 years had a higher rate (RR 3.2, 95% confidence interval (95% CI) 1.2 to 8.6) of sick leave than younger men, whereas among the women aging seemed to decrease the rate.

The effect of job experience according to sex and work load (table 8). In high load tasks new male workers were 2.5-fold more likely to have sick leave during their first year of employment, and from their second year on were sevenfold more likely to have sick leave due to neck and shoulder disorders than experienced workers. In men who did low work load tasks the rate of sick leave among first year workers was about the same as the rate of the experienced workers, but from the second year on, the rate was lower than that of the experienced workers.

The effect of *sex* on the rate of sick leave due to neck and shoulder disorders was dependent on age and job experience (table 9). Young women (<30 years) had an increased rate compared with men in all job experience categories. Experienced female workers had a higher rate than men in all age groups, but the rate seemed to decrease with age.

Table 6 Effect of work load on the rate of sick leave due to upper limb disorders in different job experience and sex groups

	Job experience					
	Experienced workers		New workers, year 1		New workers, year 2+	
Work load	*Men*	*Women*	*Men*	*Women*	*Men*	*Women*
Low	1.0	1.0	1.0	1.0	1.0	1.0
High	0.5	1.9	2.8	10.2	1.8	6.6

Table 7 Effect of job experience on the rate of sick leave due to upper limb disorders in different work load groups

	Work load	
Job experience	*Low*	*High*
Experienced workers	1.0	1.0
New workers, year 1	0.6	3.0
New workers, year 2+	1.1	3.9

Table 8 Effect of job experience on the rate of sick leave due to neck and shoulder disorders in different work load and sex groups

	Work load			
	Low		*High*	
Job experience	*Men*	*Women*	*Men*	*Women*
Experienced workers	1.0	1.0	1.0	1.0
New workers, year 1	1.1	0.3	2.5	0.8
New workers, year 2+	0.6	0.1	7.2	0.8

Low back disorders

No significant associations were found between the predictors and low back disorders.

CHANGING WORK LOAD CATEGORY AND ENDING EMPLOYMENT

Changing work load category was rare: only 9% of experienced workers and 6% of new workers changed to another work load category during the follow up. Changing from high to low was as common as changing to the opposite direction. Seven workers (4%) among the experienced workers and 11 (3%) among the new workers changed from high to low work load category. Before the change the experienced workers had had 3.7% days off due to musculoskeletal disorders, whereas those remaining in high load group (n=56)

Table 9 Effect of sex on the rate of sick leave due to neck and shoulder disorders in different job experience and age groups

	Experienced workers			*New workers, year 1*			*New workers, year 2+*		
Sex	*<30*	*30–40*	*>40*	*<30*	*30–40*	*>40*	*<30*	*30–40*	*>40*
Male	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Female	12.8	2.9	1.9	4.0	0.9	0.6	1.4	0.3	0.2

were absent 2.2% of working days. Among the new workers the corresponding percentages were 2.6 for those changing and 3.9 for those continuing (n=177) in the high load group.

Ending employment was not associated with the rate of sick leave due to musculoskeletal disorders among new or experienced workers.

Discussion

The results of our study show that the rate of sick leave due to disorders of the upper limbs was higher among new than among experienced workers, especially in the high work load group. Adjustment for other potential confounders did not attenuate this difference. Moreover, in physically strenuous tasks the women had a higher risk than the men. These associations were independent of age. The rate of neck and shoulder disorders was high among new male workers in the high work load group.

The first result corroborates the findings of Thompson *et al*[10] as well as those of Park *et al*.[21] Thompson and his coworkers found 544 incident cases of tenosynovitis and peritendinitis in a car manufacturing factory, in which many new workers were employed after the second world war. Being unaccustomed to work, resuming work after absence, and repetitive tasks, were considered to be important factors in the aetiology of the disorders. Park *et al* found high rates of upper limb disorders in some high exposure categories in an automotive assembly factory during the first 6 months of new job assignments. A work assignment was considered to be new if it included at least a 1 week period after a change in any of the following: department, job classification, shift, or resuming work after a period of at least 2 weeks.

Our preliminary analysis also showed an increased risk of occupational accidents and infections for the new workers. The proportions in table 3 suggest a twofold to 2.5-fold risk of occupational accidents and 1.5-fold to twofold risk of infections. Separate models with accidents and infections as outcome showed that job experience remained a significant explanatory variable in both models, but the relative risk decreased (data not shown). On the contrary, the risk of disorders of the upper limbs for the new workers increased to the level of 3–4 in the final log-linear model. Work load was not associated with infections, and increased the risk of occupational accidents only slightly. The modelling with these different disease or accident groups as outcome showed different predictors and different strengths of association, disorders of the upper limbs showing the strongest association with physical work load and job experience.

Force, repetition, and postural factors have been considered to be the most important categories of risk factor in manually strenuous tasks.[1] Several studies on different types of jobs have shown that the performance of workers with less experience differs from that of workers who have worked for longer. In a study of wrist disorders, Malchaire *et al*[22] found that people who have worked longer exerted less force in manual tasks. This was suggested to arise from differences in skills between people with different durations of employment. Gray and Marras[23] studied the performance of novice and expert track workers who were driving in railway spikes, a task demanding force and accuracy. They concluded that experienced workers used a ballistic technique in striking, by flexing their elbows and using wrist motion more efficiently than novices.

There may be several reasons for the slightly higher rate of sick leave from the second year onwards than during the first year. Firstly, the disorders may require a certain induction time of exposure and a latency time to manifest as clinical disease. Periods of sick leave at the start of employment were rare. On the other hand, the smaller rate of sick leave during the first year, especially at the beginning of it, could have also been caused by unwillingness to seek medical care during the 4 month probation due to the fear of not being employed permanently. This did not, however, seem to be the case, as no increase in rates of sick leave after the probation was found. Health based selection—that is, subjects with disorders having left employment—could be a third explanation. Leaving employment during the first year was independent of the rate of sick leave. It was also independent of the work load category. We saw in separate analyses among the new workers that the duration of sick leave tended to increase during the second year, suggesting more severe disorders with increasing exposure time (Häkkänen *et al*, unpublished data).

Changing work load category was rare, and no consistent associations were found with the disorders. Among the experienced workers the proportion of sick leave among those changing from high to low work load was higher than that of those remaining in the high load category, whereas among the new workers the situation was the opposite.

Women had a higher rate of sick leave due to disorders of the upper limbs than men, especially in the high work load group. Among both experienced workers and young new workers, women also had a higher rate of sick leave due to neck disorders than did the men. This finding is in line with the results of Leijon *et al*[24] who reported sex differences in sick leave due to musculoskeletal disorders in Sweden. The effect of sex is, however, difficult to pinpoint in field studies, because women and men are usually engaged in different tasks, and therefore sex differences may entail differences in exposure. The interaction between sex and work load in our study was obviously due to different tasks in different work load groups.

The proportion of days of sick leave among experienced workers was around 5%–6%,

which was typical for the metal industry in Finland at the beginning of the 1990s.[25] However, compared with a large Finnish forest industry enterprise with several occupations, the time that our workers spent on sick leave due to musculoskeletal disorders was 2.5-fold greater.[26] Infections, musculoskeletal disorders, and occupational accidents were the major causes of the high percentages of absenteeism among the new workers. The use of pneumatic hand tools and the demand for high forces in this kind of work increase not only the risk of musculoskeletal disorders but also the risk of accidents. The high occurrence of occupational accidents reflects the inadequate training in work methods. Due to the rapidly growing markets, many new workers were employed by the factory during the follow up time. The turnover rate was high and the proportion of those working for the entire follow up time was low. After stratifying the data according to job experience and age, the exposure times remained short in some worker groups, which does not allow comparison of the rates without uncertainty. However, even in the groups with short exposure times, the results showed some uniform trends.

Our analyses showed an overdispersion of the response variables relative to the variance of the Poisson distribution. This might have been caused by some factors relevant to the response, which had not been measured. Another potential reason for the overdispersion could have been a clustering of days of sick leave—that is, if a worker was on sick leave for 1 day, he or she would more likely to be off work for the next day or days. Undoubtedly, there is also some variability between workers in proneness to absence.

In this study we used the number of days of sick leave as a measure of morbidity. It has been said that sickness absence may reflect the workers' perceptions of their ill health rather than the physical disease.[27] Studies on the association between medically certified sick leave and occupational characteristics have shown that sick leave can be used as an integrated indicator of health outcomes.[16 17] In a study among nurses, sick leave was associated with work load defined as the nurse:patient ratio and the patient's duration of hospital stay.[16] Because in our study the diagnoses were made and the sick leave prescribed by the same physician throughout the study, the data can be considered fairly stable over time and likely to reflect the occurrence of and disability due to various diseases, musculoskeletal disorders in particular.

The identification of workers at risk and the recognition of early symptoms are essential for the prevention of musculoskeletal disorders, especially those of the upper limbs. Special attention should be paid to newly employed workers, as being unaccustomed to the work seems to increase the risk of musculoskeletal disorders.

1 Bernard BP, ed. *Musculoskeletal disorders and workplace factors. A critical review of epidemiologic evidence for work-related musculoskeletal disorders of the neck, upper extremity, and low back, 2nd ed.* Cincinnati: National Institute for Occupational Safety and Health, 1997.
2 Wieslander G, Norback D, Gothe CJ, *et al*. Carpal tunnel syndrome (CTS) and exposure to vibration, repetitive wrist movements, and heavy manual work: a case-referent study. *Br J Ind Med* 1989;**46**:43–7.
3 de Krom MC, Kester AD, Knipschild PG, *et al*. Risk factors for carpal tunnel syndrome. *Am J Epidemiol* 1990;**132**: 1102–10.
4 Ritz BR. Humeral epicondylitis among gas and waterworks employees. *Scand J Work Environ Health* 1995;**21**:478–86.
5 Ohlsson K, Attewell R, Skerfving S. Self reported symptoms in the neck and upper limbs of female assembly workers. Impact of length of employment, work pace, and selection. *Scand J Work Environ Health* 1989;**15**:75–80.
6 Ohlsson K, Hansson GÅ, Balogh I, *et al*. Disorders of the neck and upper limbs in women in the fish processing industry. *Occup Environ Med* 1994;**51**:826–32.
7 Punnett L. Ergonomic stressors and upper extremity disorders in vehicle manufacturing: cross sectional exposure-response trends. *Occup Environ Med* 1998;**55**:414–20.
8 Brisson C, Vinet A. Effect of duration of employment in piecework on severe disability among female garment workers. *Scand J Work Environ Health* 1989;**15**:329–34.
9 Burdorf A, Naaktgeboren B, Post W. Prognostic factors for musculoskeletal sickness absence and return to work among welders and metal workers. *Occup Environ Med* 1998;**55**:490–5.
10 Thompson AR, Plewes LW, Shaw EG. Peritendinitis crepitans and simple tenosynovitis: a clinical study of 544 cases in industry. *Br J Ind Med* 1951;**8**:150–60.
11 Park R, Krebs J, Mirer F. Mortality at an automotive stamping and assembly complex. *Am J Ind Med* 1994;**26**:449–63.
12 Alexanderson K. Sickness absence: a review of performed studies which focused on levels of exposures and theories utilized. *Scand J Soc Med* 1998;**26**:241–9.
13 Hensing G, Alexanderson K, Allebeck P, *et al*. How to measure sickness absence? Literature review and suggestion of five basic measures. *Scand J Soc Med* 1998;**26**:133–44.
14 Kurppa K, Viikari Juntura E, Kuosma E, *et al*. Incidence of tenosynovitis or peritendinitis and epicondylitis in a meat-processing factory. *Scand J Work Environ Health* 1991;**17**: 32–7.
15 Viikari-Juntura E, Kurppa K, Kuosma E, *et al*. Prevalence of epicondylitis and elbow pain in the meat-processing industry. *Scand J Work Environ Health* 1991;**17**:38–45.
16 Bourbonnais R, Vinet A. Certified sick leave as a non-specific morbidity indicator: a case-referent study among nurses. *Br J Ind Med* 1992;**49**:673–8.
17 Marmot M, Feeney A, Shipley M, *et al*. Sickness absence as a measure of health status and functioning: from the UK Whitehall II study. *J Epidemiol Community Health* 1995;**49**: 124–30.
18 Häkkänen M, Viikari Juntura E, Takala EP. Effects of changes in work methods on musculoskeletal load. An intervention study in the trailer assembly. *Appl Ergon* 1997; **28**:99–108.
19 Zeger SL, Liang KY. Longitudinal data analysis for discrete and continuous outcomes. *Biometrics* 1986;**42**:121–30.
20 SAS Institute. *SAS/STAT Software: changes and enchancements for release 6.12*. Cary, NC: SAS Institute, 1996.
21 Park RM, Krebs JM, Mirer FE. Occupational disease surveillance using disability insurance at an automotive stamping and assembly complex. *J Occup Environ Med* 1996;**38**:1111–23.
22 Malchaire JB, Cock NA, Robert AR. Prevalence of musculoskeletal disorders at the wrist as a function of angles, forces, repetitiveness and movement velocities. *Scand J Work Environ Health* 1996;**22**:176–81.
23 Gray BA, Marras WS. An experimental analysis of railroad spike maul methods. *Hum Factors* 1989;**31**:335–44.
24 Leijon M, Hensing G, Alexanderson K. Gender trends in sick-listing with musculoskeletal symptoms in a Swedish county during a period of rapid increase in sickness absence. *Scand J Soc Med* 1998;**26**:204–13.
25 Federation of Finnish Metal Engineering and Electrotechnical Industries (FIMET). *Working time statistics*. Helsinki: FIMET 1999.
26 Viikari-Juntura E, Riihimäki H, Malmivaara A, *et al*. Sairauslomat ja tapaturmat metsäteollisuuden yrityksessä (Sick leaves and accidents in a forestry industry enterprise). Helsinki: Finnish Work Environment Fund, Finnish Institute of Occupational Health, 1993.
27 Kristensen TS. Sickness absence and work strain among Danish slaughterhouse workers: an analysis of absence from work regarded as coping behaviour. *Soc Sci Med* 1991;**32**:15–27.