ORIGINAL ARTICLE

Incidence of shoulder pain in repetitive work

A Leclerc, J-F Chastang, I Niedhammer, M-F Landre, Y Roquelaure, Study Group on Repetitive Work

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See end of article for authors' affiliations

Correspondence to: Ms A Leclerc, INSERM Unité 88, Hôpital National de Saint-Maurice, 14 rue du val d'Osne, 94415 Saint-Maurice Cedex, France; Annette.Leclerc@st-maurice.inserm.fr

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Aims: To determine the predictiveness of personal and occupational factors for the onset of shoulder pain in occupations requiring repetitive work.

Methods: A sample of 598 workers in five activity sectors completed a self administered questionnaire in 1993–94 and again three years later. Both questionnaires included questions about shoulder pain. The associations between various factors at baseline and subsequent shoulder pain were studied among subjects free from shoulder pain at baseline.

Results: The incidence of shoulder pain was associated with several independent risk factors: depressive symptoms, low level of job control, and biomechanical constraints. After adjustment for other risk factors, the presence of depressive symptoms predicted occurrence of shoulder pain. A low level of job control was also associated with the onset of shoulder pain in both sexes. For men, repetitive use of a tool was a strong predictor, while the two most important biomechanical risk factors for women were use of vibrating tools and working with arms above shoulder level.

Conclusion: This study used a longitudinal approach to examine different sets of risk factors for shoulder pain simultaneously. The results confirm the role of several biomechanical constraints. Psychological symptoms and a low level of job control also play a role.

Shoulder pain (SP) is frequent in the general population. In a recent survey of the general population of the Netherlands, 21% reported SP at the time of questioning; similar figures have been reported for other countries.[1] SP or specific disorders such as rotator cuff syndrome and shoulder tendinitis are especially frequent among workers in the following industries: clothing,[2–4] slaughtering and food processing,[5 6] fish processing,[7] repetitive assembly line work,[8 9] and among supermarkets cashiers.[10] It is an important burden, with high costs in several countries.[1 11 12] There have been few studies on shoulder disorders. Moreover, shoulder and neck disorders are not always distinguished, although their risk factors may differ. A recent review of occupational risk factors for SP included 29 studies. Three were case-control studies, and none had a longitudinal design.[13]

Several reviews, based primarily on cross sectional studies, indicate that the risk factors include working with arms above shoulder level and other awkward postures (for example, with trunk flexed forward), hand-arm vibrations, repetitive movements, pushing and pulling, and carrying loads supported by the shoulder.[13–17] Many cross sectional studies report associations with psychosocial risk factors, but the results are inconsistent across studies.[13] We have found only four longitudinal studies of SD. Two of them looked at sewing machine operators.[3 18] Another one was conducted in a large population of workers in a Finnish forestry company,[19] and the last one in several companies—rail catering, flower auction, nursing home, postal distribution, and refuse collection.[15]

The results presented here come from the continuation of a cross sectional study conducted in 1993–94 among workers exposed to repetitive work.[20] Three years later, a sub-sample of the workers from that study were included in a follow up longitudinal study. Results for the prevalence of carpal tunnel syndrome (CTS)[20] and the incidence of several upper limb disorders (CTS, lateral epicondylitis, and wrist tendinitis)[21] have been published. Results about the prevalence of shoulder disorders have been published for the entire sample and for the subpopulation of supermarket cashiers.[10 22 23] The prevalence, based on clinical examination, was 28.9% among those exposed to repetitive work, significantly higher than in the unexposed group (16%). The objective of the present study was to examine the predictiveness of personal and occupational factors for the onset of SP.

SUBJECTS AND METHODS

Population

In 1993–94, 1420 workers whose occupations required repetitive work completed a self administered questionnaire about their working conditions and upper limb disorders and underwent a standardised physical examination.[20] They were selected according to occupational criteria and were required to be exposed to repetitive work, in one of the following activity sectors:

- Assembly line work in the manufacture of small electrical appliances, motor vehicle accessories, or ski accessories (packaging excluded)
- Clothing and shoe industry (packaging excluded)
- Food industry, packaging excluded (mainly meat cutting)
- Packaging (primarily in the food industry)
- Supermarket cashiers.

The sample also included 337 subjects not exposed to repetitive work.

Among the 39 occupational physicians who conducted the cross sectional study, 18 could repeat it three years later for the subjects exposed to repetitive work.[21]

The target population of the longitudinal study was the 700 workers (at 18 different firms) examined in the 1993–94 survey by the 18 physicians. Overall, 102 (15%) were lost to

Abbreviations: CTS, carpal tunnel syndrome; SP, shoulder pain

Main messages

- There have been few longitudinal studies on incidence of shoulder pain.
- In this study, incidence was increased in the presence of several biomechanical constraints: repetitive use of a tool, use of vibrating tools, working with arms above shoulder level.
- Psychological symptoms and a low level of job control also played a role.

Policy implications

- In planning the prevention of shoulder pain, several dimensions must be considered, in addition to the biomechanical dimensions, especially the consequences of a low level of job control.
- For a better knowledge of the temporal relations between exposure and the occurrence of shoulder pain, and the dose-response relations, longitudinal studies should be developed.

follow up, mostly because they no longer worked for the same company.

Most of the remaining 598 workers had the same (or similar) occupational constraints as they had had three years earlier. Four no longer worked at the same firm, and 134 (22.4%) said that their job or their workstation had changed since the earlier survey, 36 for medical reasons. Table 1 describes the sample.

Shoulder pain (SP)

SP incidence was assessed from the answers to the self administered questionnaires. Subjects free from SP at baseline were those who did not report SP in the six months preceding the first questionnaire (1993–94). Incident cases were defined as the subjects free from SP at baseline who reported experiencing it at least one day in the six months preceding the second questionnaire (1996–97). The two questionnaires were the same, with a question about shoulder pain and a mannequin indicating the anatomical areas for shoulder, neck, and upper back: the workers were asked to mark the region of their pain on the sketch with a pencil. If the answer to the question about SP differed from the site of pain indicated on the sketch, the questionnaire was reviewed. Most of those situations arose when subjects complained of ''shoulder'' pain but actually suffered in the neck or upper back areas. In those situations, priority was given to the drawing.

We decided to rely on the self administered questionnaire rather than on the diagnoses of ''shoulder tendinitis'' by the occupational physicians. The portion of the medical questionnaire covering shoulder tendinitis at follow up was different from that in the first examination: it was slightly modified because of the difficulties encountered in reaching a standardised definition of shoulder tendinitis at the first examination.

In this study, ''prevalence'' was a period prevalence, for the six months preceding the questionnaire. ''Incident'' shoulder pain was reported by subjects who were not among the prevalent cases at the first questionnaire (that is, were free of SP then) and complained of SP at the second questionnaire. While the term ''incidence'' is used for simplicity's sake, it does not include here shoulder pain that appeared after the first questionnaire and disappeared before the reference period of the second.

Potential risk factors

The list of potential risk factors included personal and occupational variables; the latter were the subject's own report of whether particular postural and biomechanical constraints and psychosocial stresses were present at work. All the risk factors studied were variables in the first questionnaire.

The list was based on the results from other studies and included variables known or suspected to be a risk factor for SP. The list was similar to that used in the analyses focusing on the incidence of carpal tunnel syndrome, lateral epicondylitis, and wrist tendinitis in this population.[21] A few additional variables were considered: bending forward, working with arms above shoulder level, and exposure to cold, which had been included in the study on shoulder disorders among cashiers,[10] and ''repetitive use of a tool'', which might have been applicable in particular to men in the meat industry who had to use a knife repetitively. On the other hand, ''turn and screw'', a risk factor for lateral epicondylitis, was not included in the list: fewer than 20 men were exposed to it, and among women, it was closely associated with the use of vibrating tools, which was used instead because more relevant to SP. Table 2 summarises the variables in the analyses.

Personal and occupational variables

The study included the following variables:

- Sex.
- Age, in four categories ($\leqslant$29; 30–39; 40–49; $\geqslant$50).
- Activity sector (five categories), and number of years on the job ($<$1; 1–$<$10; $\geqslant$10).
- Smoking (non-smoker, ex-smoker, smoker).
- Body mass index (BMI), in two categories, overweight or not; overweight was defined as BMI $>$27 kg/m^2 for men and $>$26.5 kg/m^2 for women.
- Presence of somatic problems; ''presence'' was defined as a yes answer to at least one of the following questions: do you often have headaches; do you often have sleep disorders; are you often bothered by your heart beating hard; do you have personal worries that get you down physically.
- Presence of depressive symptom(s); ''presence'' was defined as a yes answer to at least one of the following problems: are you in low or very low spirits most of the time; are you often bothered by nervousness; do you often feel that nothing ever turns out the way you want it to; do you sometimes wonder if anything is worthwhile any more.
- Total number of proved or suspected diagnoses, other than shoulder tendinitis: 0, 1, 2, or more, from the list of 33 diagnoses in the medical questionnaire.

Postures and biomechanical constraints

The list is given in table 2.

Psychosocial work factors

Four psychosocial work factors were considered: job control, job demand, social support at work, and satisfaction at work. For job control a score from 0 to 8 was calculated as the sum of the following yes/no items: no choice of the timing of breaks; unscheduled short breaks not possible; pace dictated by the machine, by colleagues, by other constraints; no

Table 1 Prevalence of shoulder pain at baseline, and incidence

	Men				Women			
	n*	Prevalence at baseline, %	Without shoulder disorder at baseline	Incident cases (incidence, %)	n*	Prevalence at baseline, %	Without shoulder disorder at baseline	Incident cases (incidence, %)
Age								
⩽29	59	34	39	13 (33)	58	31	40	8 (20)
30–39	72	32	49	13 (27)	153	49	78	18 (23)
40–49	37	46	20	5 (25)	166	51	81	16 (20)
⩾50	10	60	4	1 (25)	43	65	15	2 (13)
Sector								
Assembly line	24	33	16	5 (31)	223	51	110	25 (23)
Clothing	11	36	7	3 (43)	52	37	33	3 (9)
Food	123	39	75	22 (29)	20	50	10	2 (20)
Packaging	20	30	14	2 (14)	83	42	48	12 (25)
Cashiers	†				42	69	13	2 (15)
Entire sample	178	37	112	32 (29)	420	49	214	44 (21)

*Number of subjects at baseline (1993–94).
†All the cashiers were women.

control over the quantity of work; no control over the pace of work; lack of variety of work. A low level of job control was defined as a score ⩾5. A high level of job demand was defined as positive answers to both questions: are you permanently overloaded with work? do you have periods with increased workload? Lack of social support was defined as a negative answer about either work relations in general or about relations with colleagues. A low level of satisfaction was defined as a negative answer either about satisfaction with the workstation or about general job satisfaction.

METHODS

All the analyses were performed separately for men and women, because they were exposed to different risk factors. The relations between the presence (or absence) of risk factors at baseline and the incidence of SP were studied first with bivariate associations and χ^2 tests. We then used logistic models to study the determinants of incidence simultaneously, with BMDP software.[24] The variables in the models were those associated with incidence at a p value of less than 0.20 in the bivariate analysis, with categories grouped when they contained fewer than 20 subjects.

Factors associated with loss to follow up

The 102 workers lost to follow up were compared with the 598 in the longitudinal study. Loss to follow up was significantly associated with age and activity sector. It was more frequent in the extreme age categories—those younger than 30 years and those at least 50 years of age—and among supermarket cashiers.

The workers subsequently lost to follow up complained of shoulder pain on the first questionnaire more often than the rest of the target group (prevalence 1.26 times greater). This selection effect was more pronounced among the younger subjects, with a substantial contribution from the supermarket cashiers, who had both a high prevalence of SP at baseline[10] and a high percentage of loss to follow up (31%), compared with the overall sample (15%).

Occupational physicians could obtain information on the reason for loss to follow up for 47 of the 102 subjects. The most frequent reasons were parental or maternity leave, resignation, and dismissal. Health reasons were reported less frequently.

Table 2 Postures and biomechanical constraints in the study (defined at baseline; self assessed)

Tighten with force*
Work with force, other than tighten*
Press with the hand*
Hit*‡
Pull*
Hold in position*
Use of a hand held tool*§
Bending forward†
Working with arms above shoulder level†
Use of vibrating tools: yes (irrespective of frequency) or no‡
Exposure to cold: often or always, versus seldom or never.

*Two categories: repetitively, versus not repetitively or never.
†Two categories: frequently versus infrequently.
‡Not studied for men, fewer than 20 exposed.
§Not studied for women, fewer than 20 exposed.

RESULTS

Prevalence and incidence of SP

The six month prevalence of SP at baseline among the 598 subjects was 45%: 37% for men and 49% for women (significant difference at a p level of 5%) (table 1). Prevalence increased with age; it was highest for the supermarket cashiers. Of the 326 subjects without SP at baseline, 76 (23%) reported incident SP. Hence the incidence rate was at least 8 per 100 person-years, since there were undoubtedly cases that both began and ended during that period. The incidence was 29% among men and 21% among women (not significantly different); it did not increase with age. Incidence was not especially high or low for either men or women in any of the activity sectors. It was lower among supermarket cashiers than in the entire sample of women, but only 13 women in this sector participated in the prospective study.

Overall, 45 incident cases involved the right shoulder, 15 the left, and 16 both. No specific associations were observed between side and sector, but the number of cases was small in some sectors, especially clothing and cashiers.

Associations between incidence and risk factors at baseline

This analysis compared subjects with incident SP with those who did not complain of SP at the second questionnaire. Subjects with SP at baseline were excluded from the analysis.

Results for men

In bivariate analyses, only four of the potential risk factors were associated with incident SP with a p value of 0.20 or less: years on the job, depressive symptoms, repetitive use of a tool, and job control (tables 2 and 3). The risk of SP was especially high among workers with less than one year on the job at baseline (6/9). Strong associations were observed for ''repetitive use of a tool'' and job control. The association with depressive symptoms was weaker (p = 0.15). Only 22 subjects had such symptoms, but their incidence of SP was 41%.

The four variables associated with SP incidence were considered simultaneously in a logistic model. The category ''less than one year on the job'' was grouped with the category ''1 to 9 years'', and the association between SP and years on the job disappeared. Three variables remained associated with SP: repetitive use of a tool (OR = 4.34), a low level of job control (OR = 3.7), and, to a lesser extent, presence of depressive symptoms (OR = 2.56).

Results for women

While the only personal factor associated with incidence in the bivariate analyses was the presence of depressive symptoms (tables 2 and 4), several biomechanical constraints were associated with SP: ''hit'', bending forward, arms above shoulder level, use of vibrating tools. Job control was also associated with incidence (p = 0.12).

When all these factors were considered simultaneously in a logistic model, none of the associations reached the 0.05 significance level. The model nonetheless suggested that several biomechanical constraints, as well as depressive symptoms and a low level of job control, increased the risk of SP. For example, the OR estimated by the model for cumulative exposure to bending forward, use of vibrating tools and a low level of job control was $1.81 \times 1.89 \times 1.46 = 4.99$.

DISCUSSION

The percentage of subjects lost to follow up in this longitudinal study was relatively low.[21] These workers complained of SP slightly more frequently at baseline, in particular the women younger than 40 years, a large proportion of whom were supermarket cashiers. While their reasons for leaving the job were not explicitly related to health problems, it is possible that workers who find their job strenuous look for another job or stop working (for women) when they have children.

A broad definition of shoulder pain (pain for at least one day) was used in this study because of the relatively small number of incident cases, and the shoulder diagnoses from the medical questionnaires were not taken into account.[25]

The six month prevalence in this study was 45% and the annual incidence rate at least 8%. The annual prevalence of shoulder trouble (ache, pain, discomfort) was 41% in a group of workers highly exposed to pushing and pulling tasks.[14] For mild or severe shoulder pain (eight days or more) the annual prevalence among Finnish forestry workers was 26%, and the annual incidence 14%.[19] Prevalence (presence of symptoms, irrespective of duration, in the last 12 months) reached 69% in a group of sewing machine operators, with annual incidence about 34%.[3] The prevalence of pain and discomfort within the past 12 months was also very high (61%) in a group of slaughterhouse workers in Denmark.[5] The 12 month prevalence of shoulder pain in a group of workers performing repetitive tasks in the food industry was 28% for women and 19% for men.[6] The prevalence of clinically diagnosed shoulder girdle pain was 31% among workers in the fish processing industry.[7] The prevalence of rotator cuff tendinitis was much lower (5.8%) among sewing machine operators in the Danish PRIM study; their criteria for diagnosis included both self reported pain and objective clinical findings.[18]

In longitudinal studies, the risk factors can be measured before the onset of the disorder and most of the bias due to the healthy worker effect is avoided.[13] What is rarely mentioned, however, is that the risk factors for incidence and prevalence may differ:

One reason is that a risk factor may have specific effects on the duration of the disease, and these may affect the relation between incidence and prevalence. If it is the case for age (which is plausible) it might explain that age is associated here with prevalence at baseline, but not with incidence.

Another reason is related to the sensitivity of incidence to the definition of ''healthy at baseline''. If the group ''healthy at baseline'' includes false-negative cases, incidence will be overestimated, since some of the incident cases should have been recorded as prevalent cases at baseline rather than incident cases. Since the threshold between cases and non-cases at baseline can be influenced by the presence or absence of some risk factors, differential errors might occur.

Table 3 Factors associated with incidence of shoulder pain for men; results from bivariate analyses and from the logistic model

	Number of subjects	Number of incident cases	Incidence (%)	Test, bivariate analyses p value	Logistic model, adjusted ORs* OR (95% CI)
Number of years on the job					
⩾10	30	7	23.3		1
1–9†	73	19	26.0	‡	1.21 (0.41 to 3.59)
<1†	9	6	66.7		
Depressive symptoms					
Absence	90	23	25.6	0.15	1
Presence	22	9	40.9		2.56 (0.86 to 7.66)
Repetitive use of a tool					
No	53	9	17.0	0.01	1
Yes	59	23	39.0		4.34 (1.58 to 11.9)
Job control					
High or medium level	60	11	18.3		1
Low level	52	21	40.4	0.01	3.68 (1.44 to 9.41)
''Healthy'' at baseline	112				
Incident cases		32			

*Each OR is adjusted on the three other risk factors.
†Grouped in the logistic model.
‡No comparison test, due to small number in one category.

Table 4 Factors associated with incidence of shoulder pain for women; results from bivariate analyses and from the logistic model

	Number of subjects	Number of incident cases	Incidence %	Test, bivariate analyses p value	Logistic model, adjusted ORs* OR (95% CI)
Depressive symptoms					
Absence	161	28	17.4	0.05	1
Presence	53	16	30.2		1.85 (0.86 to 3.99)
Hit					
No	183	34	18.6	0.08	1
Yes	31	10	32.3		1.47 (0.58 to 3.73)
Bending forward					
Infrequently	99	14	14.1	0.03	1
Frequently	115	30	26.1		1.81 (0.86 to 3.82)
Arm above the shoulder					
Infrequently	129	20	15.5	0.02	1
Frequently	85	24	28.2		1.84 (0.89 to 3.79)
Use of vibrating tool					
No	169	29	17.2	0.02	1
Yes	45	15	33.3		1.89 (0.86 to 4.15)
Job control					
High or medium level	129	22	17.0	0.12	1
Low level	85	22	25.9		1.46 (0.72 to 2.67)
Subjects ''healthy'' at baseline	214				
Incident cases		44			

*Each OR is adjusted on the five other risk factors.

A problem in interpreting incidence findings in a highly exposed population is that many workers are already affected at baseline. The ''healthy'' workers at baseline represent a selected group, since they are unaffected despite a high level of occupational exposure. The risk factors of subsequent SP may be specific to workers who withstood occupational constraints for years.

Inter-study comparisons of the role of duration of exposure are difficult because bias from the healthy worker effect is plausible in some industrial contexts but less so in others.[18] In our study, incidence was not higher among workers with a long job duration, but it was particularly high among men on the job only a short time. Similar results have been observed for prevalence in the fish processing industry.[7] Those authors suggested that lack of training might explain the finding.

The study design enabled us to include 18 different companies in various activity sectors. This was on the whole an advantage but did comport substantial limitations in occupational exposure assessment. The results relied on self assessment of biomechanical constraints, which prevents a very precise evaluation.[8 15 26] The large number of firms involved in this study would have made it quite difficult to rely on direct exposure measurements.

It is plausible that the workers indicated only those biomechanical constraints most relevant to them in view of the length of the list. This might explain some of the inconsistent positive and negative results: for example, the answer ''work with force, other than tighten'' was probably not used by workers who had answered that they had to ''hit'' repetitively, even though hitting (in assembly line work) implies working with force. Similarly, men in the meat industry who had to use a knife, for example for deboning, generally did not indicate that they had to work with force. In the analysis they were classified as exposed to repetitive use of a tool.

The validity of the questions on psychosocial risk factors could also be discussed; for example, the same questions might have slightly different meanings in different industrial sectors or firms.

This study has several other limitations. The number of cases was relatively small, with many risk factors; chance could explain some of the results. Nonetheless the results for men and women are consistent for the risk factors common to both; this strengthens the validity of the results. The study did not allow us to test hypotheses about some risk factors that were relatively infrequent in this population, such as carrying weights on one shoulder, pushing and pulling, lifting or carrying heavy weights.[13–15 17 27 28] The role of exposure to repetitive work[13 27] was not studied for incidence, since the subjects not exposed to repetitive work were not included in the longitudinal part of the study. The prevalence of SP among the workers who had responded to the first questionnaire was significantly higher among those exposed to repetitive work.[22 23]

Despite these limitations, the results confirm the role of biomechanical hazards, which have heretofore been studied primarily in cross sectional studies. Results for men and women differed, not surprisingly, since men and women workers tend to perform different tasks, in this population and most others.[28]

SP was associated with working with arms above shoulder level among women; this is consistent with cross sectional and case-control studies.[17 27 29 30] Our results about women and vibrating tools are also in accordance with the literature.[13 17] Another risk factor for women in this study was bending forward. Other authors have concluded that bending forward, stretching down, non-neutral or awkward postures,[8 13 27 29] are risk factors for prevalence.

''Hitting'' had also a predictive role for women in this study. In the context of this survey it corresponds mainly to repetitive movements of the upper limbs, requiring force, especially in assembly line work. This is probably similar to repetitive forceful movement.[5 6 31]

Repetitive use of a handheld tool was a strong risk factor for men. In most cases, it referred to repetitive use of a knife, again a repetitive forceful movement. In the fish processing industry, sustained forceful movement was also a risk factor for shoulder pain.[7]

The results of this longitudinal study indicate that biomechanical hazards are not the only risk factors for SP. In this study, ''depressive symptoms'' (which included an item on nervousness) and a low level of job control each independently affected the incidence of SP. These associations were observed in both sexes.

In several follow up studies, psychological factors predicted changes in neck-shoulder symptoms[32] or incidence of shoulder pain.[19] A literature review has concluded that the emotional dimension plays a role in the incidence of back and neck pain,[33] but its mechanisms remain unknown. Psychological conditions may plausibly cause direct biological effects. Other mechanisms might be explored through qualitative approaches: interviews may be a better method for taking into account the context of psychological symptoms, including their relation with work.

Job control was also predictive here, independently, for men and (to a lesser extent) for women. Several good quality studies have reported positive associations between job control and the onset of shoulder symptoms.[13] A plausible mechanism for the role of job control in our study is that the lack of control over the pace of work and the lack of unscheduled breaks makes it impossible for have adequate periods of low activity for the muscles.[13] Another longitudinal study found that a low level of social support among women sewing machine operators was associated with incidence of shoulder disorders. The hypothesis about the mechanism involved job control, in particular, the lack of opportunities for individual organisation and taking breaks when needed.[18]

Other non-biomechanical risk factors might include participation in sports or other leisure activities, and the role of housework for women, which we did not study.[13 19 29]

Several dimensions must be considered in planning the prevention of SP, especially in repetitive work. These include the role of specific repetitive motions such as ''hitting'' or the repetitive use of tools such as knives, both of which imply the use of force; the use of vibrating tools; non-neutral postures, especially work with arms above shoulder level; and the role of job control. It would also be useful to improve our knowledge of the temporal dimensions, more specifically, of the induction periods for different risk factors.[29] For that purpose, more longitudinal studies are needed.

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Authors' affiliations

A Leclerc, J-F Chastang, I Niedhammer, M-F Landre, INSERM Unité 88 (National Institute on Health and Medical Research), Saint Maurice, France – IFR 69

Y Roquelaure, Service de pathologie professionnelle, CHU, Angers, France

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