## ELECTRONIC PAPER

# Prognosis of shoulder tendonitis in repetitive work: a follow up study in a cohort of Danish industrial and service workers

**J P Bonde, S Mikkelsen, J H Andersen, N Fallentin, J Baelum, S W Svendsen, J F Thomsen, P Frost, G Thomsen, E Overgaard, A Kaergaard, and the PRIM Health Study Group**

.......................................................................................................................

See end of article for authors' affiliations
......................

Correspondence to:
Dr J P Bonde, Department of Occupational Medicine, Aarhus University Hospital, Nørrebrogade 44, Building 2C, DK-8000 Århus C, Denmark; JPBON@aaa.dk

Accepted
14 February 2003
......................

**Background:** The physical and psychosocial work environment is expected to modify recovery from shoulder disorders, but knowledge is limited.

**Methods:** In a follow up study of musculoskeletal disorders in industrial and service workers, 113 employees were identified with a history of shoulder pain combined with clinical signs of shoulder tendonitis. The workers had yearly reexaminations up to three times. Quantitative estimates of duration, repetitiveness, and forcefulness of current tasks were obtained from video recordings. Perception of job demands, decision latitude, and social support was recorded by a job content questionnaire. Recovery of shoulder tendonitis was analysed by Kaplan-Meier survival technique and by logistic regression on exposure variables and individual characteristics in models, allowing for time varying exposures.

**Results:** Some 50% of workers recovered within 10 months (95% CI 6 to 14 months). Higher age was strongly related to slow recovery, while physical job exposures were not. Perception of demands, control, and social support at the time when the shoulder disorder was diagnosed, were associated with delayed recovery, but these psychosocial factors did not predict slow recovery in incident cases identified during follow up.

**Conclusion:** The median duration of shoulder tendonitis in a cross sectional sample of industrial and service workers was in the order of 10 months. This estimate is most likely biased towards too high a value. Recovery was strongly reduced in higher age. Physical workplace exposures and perceived psychosocial job characteristics during the period preceding diagnosis seem not to be important prognostic factors.

Shoulder disorders are common causes of pain and disability. The incidence in UK primary care was 2 per thousand per year in people less than 25 years, and peaked at 15 per thousand per year in people aged 65–74.[1] Similar rates were observed in Dutch general practice (average cumulative incidence 11.2 per thousand per year) in which rotator cuff tendonitis was the most frequently recorded clinical entity (29%).[2] High prevalences of shoulder disorders have been observed in occupational settings.[3] Non-rheumatic shoulder disorders (subsequently referred to as shoulder tendonitis) are expected to resolve in the majority of cases,[4] but follow up studies to characterise the natural history and modifiers of the spontaneous course are few.[5–8] In a clinical series of 137 conservatively treated patients, 24% had active tendonitis 19 months later.[5] Recovery from shoulder tendonitis might be different in currently employed workers, but population based follow up studies of shoulder tendonitis

have to our knowledge never been published. Knowledge about recovery from shoulder tendonitis and about individual and work related modifiers of recovery would be useful for the general and the occupational health physician. In particular, it is of interest to examine whether recovery is delayed in workers with strenuous repetitive work. In this paper we report on occupational and individual modifiers of the long term outcome of shoulder tendonitis in 113 industrial workers that were identified in a Danish nationwide occupational study on musculoskeletal disorders in monotonous repetitive work.[9]

## POPULATION AND METHODS

From a cross sectional sample of 4198 male and female employees in 19 Danish companies, 3073 contributed data for this study (participation rate 73.4%). With the exception of apprentices all male and female workers were eligible. They were enrolled into the study by one of three hospital departments of occupational medicine. The respondents completed questionnaires on physical and psychosocial job exposure, psychosomatic symptoms, lifestyle, and spare time activity at baseline and at three follow up examinations. Within the group of 3073 respondents we identified 167

---

**Main messages**

- Recovery of clinically verified shoulder tendonitis in industry and service workers is in most cases a matter of several months.
- While higher age substantially slows down the rate of recovery, physical work characteristics seem not to be important modifiers of the course of the disease.
- Perception of high job demands, low job control, and social support at the workplace are strongly related to slow recovery, but may be a consequence rather than a cause of the disorder.

---

**Policy implications**

- Occupational health management and counselling of patients with clinical shoulder disorders should acknowledge the favourable but often slow course of shoulder tendonitis.

workers with clinical signs of tendonitis in one or both (15 individuals) shoulders—either at a baseline on-site clinical examination in 1994–95 (92 subjects) or during three subsequent years of follow up with intervals spanning 6–18 months (75 subjects). Clinical follow up data were available for 113 workers suffering from right (n = 51), left (n = 52), or double sided shoulder tendonitis (n = 10), 68 of which were identified at baseline. Lacking clinical follow up data were due to drop out ((n = 27), missed clinical examination ((n = 13), or because of shoulder tendonitis diagnosed at the last follow up examination ((n = 14). Thus the loss to follow up was 26% in cases identified at baseline as well as during follow up (1–68/92, respectively 1–45/(75–14)). The entire study population was addressed by a postal questionnaire on musculo-skeletal symptoms at baseline and at each of the three follow ups. Sick listed workers were included on the mailing lists while workers who had left the companies after the first round were not. Clinical examinations were undertaken on all subjects at baseline, while only workers fulfilling specified pain/disability criteria were examined during follow up. The sensitivity of the postal questionnaire with regard to identification of rotator cuff tendonitis was 90% and the specificity was 80%.[10] Participants gave written consent and the appropriate ethics committees approved the study protocols. The study population has been described in detail elsewhere.[9 11]

## Shoulder tendonitis

A history of shoulder complaints (pain and disability) combined with direct and indirect tenderness in the shoulder region constituted the three sufficient and necessary criteria for shoulder tendonitis. Self reports on shoulder complaints were obtained by ticking each of four numeric box complaint scales from 0 (no complaints at all) to 9 (pain as bad as could be), dealing with, respectively: worst complaints in past 3 months, average complaints in past 3 months, disability (work or leisure) in past 3 months, and complaints in past 7 days. Scores for the four modalities were summed to obtain a *shoulder pain index* ranging from 0 to 36. A score of 12 or more was the a priori and arbitrary cut off value defining shoulder pain.[12] Complaints from other body regions, including neck and elbows, were indexed the same way. A similar approach to define shoulder symptoms in population surveys has been proposed by others.[13 14] *Direct tenderness* was considered positive if palpation on the major tubercle elicited tenderness, avoiding reaction or jump sign, or if passive internal rotation of the abducted upper arm elicited pain in the shoulder (positive impingement sign: yes versus no/atypical). Palpation was with a pressure of approximately 4 kg by the thumb perpendicular to the surface of the major tubercle. We defined *indirect tenderness* as pain in the front of the shoulder elicited by active resisted abduction in the shoulder (yes versus no/atypical). Nine medical doctors undertook the clinical examinations on-site according to a detailed clinical protocol with comprehensive descriptions of all procedures. The examiners were trained in use of the clinical protocol at a two day seminar before the onset of the study. All examinations were blinded to the answers from the questionnaire.

The examination also included pressure algometry (So-medic, Farsta, Sweden) on the vastus medialis (middle of the thigh) and tibia (bone recording), and measurement of shoulder strength using an Isobex muscle strength analyser (ISOBAR, Crumbed ERG, Bern, Switzerland). Standing upright, the upper arm was held abducted to 90° in the scapular plane with a straight elbow. A strap connected to a strain gauge force transducer anchored at a table was placed at the wrist, and the participant performed maximal voluntary resisted abduction of the arm. For each shoulder, the best of three recordings of the exerted force was recorded as shoulder strength. Table 1 shows results of pressure algometry and shoulder strength measurements in subjects with and without shoulder tendonitis. If one or more of the above criteria for shoulder tendonitis was no longer fulfilled at subsequent examinations, the individual was considered to have recovered.

## Exposure assessment

Physical exposures were characterised by worker independent observational methods at baseline with an update at each follow up. Ergonomists identified a total of 425 different work tasks at the 19 workplaces by several company visits. Work tasks were classified as either repetitive or non-repetitive. A repetitive task was one that involved continuous repetitive hand or arm movement (examples: data entering, packing, letter sorting, shop cashier, machine feeding, deboning, sewing). A non-repetitive task was characterised by varied work (office work, internal transportation, supervision). Repetitive work tasks judged to have comparable levels of repetitiveness, postural loads, and force requirements were aggregated, resulting in 103 grouped tasks. Between one and seven workers in each of the 103 task groups were videotaped from three different camera angles for at least 10 working cycles or for a minimum of 10 minutes. The task cycle time, duration of exertion (percentage of cycle time), and the number of wrist and shoulder movements per minute was quantified, based on repeated reviews of the video recordings. Each of the 103 repetitive task groups was assigned the median value of 1 to 7 observed values. Finally, a time weighted exposure measure was allocated to each participant on the basis of self reported task distribution during a normal working week of 37 hours. The individual task distribution was obtained by a worksite specific questionnaire listing all possible tasks at that specific company. Participants reported their job tasks (up to a maximum of five tasks) and the time spent on these tasks. The exposure measure was calculated by summing the products of task group exposure medians (levels) and proportion of time per week spent in each task group ($\sum_1^5$ percentage time/week * level (median of task group measures)).

Workers were classified as doing repetitive work if at least one of their tasks belonged to a repetitive task group (2.187); otherwise they were classified as doing non-repetitive work (637). A total of 249 workers had work that could not be allocated to a task group and these were excluded from further analysis. Among workers in repetitive tasks, 55% had only one task during a week. The 45% of workers with more than one task spent on average 31% (range 2–50%) of their total working time in repetitive work. Force requirements were subjectively estimated from the videotape recordings and categorised into five levels (<10%, 10–29%, 30–49%, 50–79%, and ≥80% of maximal voluntary contraction).[11]

Perceived psychosocial work characteristics were assessed using the Whitehall II version of Karasek's job content questionnaire,[15] including questions on job demands (three items, for example, "Is it necessary to work very fast?"), job control (14 items, for example, "Do you have freedom to decide how to do your job?"), and social support at the work place (six items, for example, "How often do you get help and support from your colleagues?"). Each item was rated on a four point scale ranging from "often", "sometimes", and "seldom" to "never/almost never". Scores for each of the three dimensions were scaled to range from 0 to a maximum of 4. The type of personality (high intrinsic effort: yes/no) was assessed with a 29 item measure adapted from Siegrist and Peter.[16] The questions deal with competitive, approving, withdrawing behaviour, and anger. Each item was rated on a four point scale ranging from "strongly disagree" to "strongly agree". Finally, each dimension was dichotomised into high/low levels by the median value of the scale scores. Missing values were extrapolated from the most frequent observed

combination of answers if at least 40% of items in a dimension were filled in. The percentage of extrapolated values for the demands, control, and social support dimensions were respectively 2.7, 11.1, and 7.2. Less than 3% of values could not be estimated.

### Design of analysis

The recovery function of workers with shoulder tendonitis was computed by Kaplan-Meier survival function analysis (SAS Statistics, the LIFETEST procedure,[17] pp. 1027–69). In workers who had recovered between two clinical examinations, the time of recovery was taken as the median date between these examinations. The estimated survival function and the logarithm of estimated survival against time were visualised on plots. Exponential survival curves were fitted if appropriate.

Using logistic regression equivalent to discrete survival analysis,[18] we analysed persistence of shoulder tendonitis during follow up in relation to individual and job characteristics at the time (round) when the disorder was detected for the first time. In these analyses the observational unit was a study round. Thus each individual contributed 1–3 observations (rounds 2–4) depending on persistence of the shoulder disorder during follow up. If, for instance, the disorder was detected at baseline and persisted through round 2 but was recovered at round 3, that person would be presented in the logistic regression by two observations (rounds 2 and 3). Examinations after the round with recovery (if any) were left out (censored). Dummy variables were assigned to associate observations belonging to the same individual (rounds 3 and 4 with round 2 as reference). In analyses of side specific mechanical exposures, the dominant shoulder only was included since no exposure data were available for the non-dominant upper extremity. All analyses were adjusted by a fixed set of four variables, which were considered for inclusion a priori regardless of associations with the outcome observed in this study. These variables included gender (woman yes/no), age (<45 y, 45–55 y, >55 y), side (right: yes/no), high intrinsic effort personality (yes/no), and algometric pressure threshold (the average pain threshold of the tibia bone and the vastus medialis muscle below 500 kPa: yes/no). We also applied logistic regression models with time varying measures of perceived and observed job characteristics. In these analyses we substituted the exposure taken at the time of diagnosis with the physical (task cycle duration, etc) and perceived (job demands, job control, etc) exposure during the round before the shoulder disorder was detected for the first time. Obviously these analyses only included the subset of participants that had the shoulder disorder diagnosed during follow up.

In order to circumvent possible problems related to missing clinical examinations, we also analysed self reported shoulder complaints during follow up without taking the clinical signs for shoulder tendonitis into account. In these analyses, the sum of numeric box scores for worst pain during the past 3 months, worst pain in past week, average pain in past three months, and shoulder disability during past 3 months were tabulated for each round of follow up, and the average scores were analysed by characteristics at baseline by multiple linear regression.

### RESULTS

Table 1 shows the characteristics of cases with shoulder tendonitis compared to the source population and differences between those participants with and without follow up. A disproportionately high occurrence of shoulder tendonitis was seen at one centre (the Herning Occupational Health Clinic). Most companies with high strain jobs, such as slaughterhouses and sewing shops were located in this area. In univariate analyses shoulder tendonitis was significantly associated with higher age, high body mass index, previous shoulder trauma, reduced shoulder strength, and lower algometric threshold (in both men and women) (table 1). Furthermore, a history of pain in the neck and elbow was also reported more frequently in subjects with shoulder tendonitis. Only small differences were observed between cases with and without follow up (table 1). In particular the physical exposures were similar.

Among 113 workers with shoulder disorder, two thirds (74 workers) had recovered at the next examination, while one

**Table 1** Demographic and clinical characteristics of workers with and without shoulder tendonitis

| | Shoulder tendonitis | | |
|---|---|---|---|
| | Yes | | No |
| Characteristic | With follow up, n=113 | Without follow up, n=54 | n=2906 |
| Center, Aarhus/Glostrup/Herning, % | 23/16/61 | 26/19/55 | 27/39/33 |
| Women, % | 61 | 62 | 58 |
| Age, years, mean (SD) | 46 (8.9) | 44 (8.7) | 38 (10.7) |
| Body mass index, kg/m², mean (SD) | 26.9 (4.8) | 26.3 (4.0) | 24.5 (4.2) |
| Physically active at least 4 hours a week, % | 30 | 40 | 27 |
| Shoulder trauma, % | 10.7 | 10.9 | 3.4 |
| Shoulder surgery, % | 0.9 | 0 | 0.4 |
| High intrinsic effort personality, % | 36.4 | 30.1 | 26.7 |
| Shoulder pain index (0–36), mean (SD) | 21.7 (7.0) | 23.3 (7.3) | 4.6 (6.9) |
| Direct shoulder tenderness (palpation or impingement), % | 100 | 100 | 14 |
| Indirect shoulder tenderness (pain at resisted abduction), % | 100 | 100 | 2 |
| Shoulder strength, kg, mean (SD) | | | |
| Men | 9.5 (2.8) | 9.7 (2.2) | 10.7 (2.3) |
| Women | 4.5 (1.9) | 3.9 (2.2) | 5.6 (1.5) |
| Pressure algometric threshold (average thigh and tibia), kPa, mean (SD) | | | |
| Men | 735 (138) | 672 (160) | 799 (200) |
| Women | 473 (155) | 525 (174) | 547 (178) |
| Neck pain index (0–36), mean (SD) | 15 (9) | 16 (8) | 6 (7) |
| Elbow pain index (0–36), mean (SD) | 9 (10) | 14 (12) | 2 (6) |
| Repetitive work, % | 76 | 70 | 64 |
| Repetitive work characteristics (median, 25–75 percentiles) | | | |
| Task cycle time, seconds | 12 (30) | 9 (23) | 19 (63) |
| Shoulder force, MVC, score 1–5 | 1 (0.5) | 1 (1.5) | 0.8 (1.2) |
| Movements in shoulder, number/minute | 15 (15) | 17 (11) | 10 (17) |

MCV, maximal voluntary contraction, categorised on 5 point ordinal scale.

**Table 2** Risk of no recovery by occupational characteristics at time of diagnosis in 113 workers with shoulder tendonitis

| Characteristics | n | OR$_{crude}$ | OR$_{adj}$* | 95% CI |
|---|---|---|---|---|
| Diagnosis | | | | |
| At baseline | 68 | 1.0 | 1.1 | 0.5 to 2.3 |
| At follow up | 45 | 1.0 | 1.0 | – |
| Gender | | | | |
| Female | 68 | 0.9 | 0.8 | 0.4 to 1.8 |
| Male | 45 | 1.0 | 1.0 | – |
| Age | | | | |
| >55 years | 24 | 3.8 | 3.8 | 1.4 to 10.7 |
| 45–55 years | 52 | 2.0 | 2.0 | 0.8 to 5.0 |
| <45 years | 37 | 1.0 | 1.0 | – |
| Intrinsic effort personality | | | | |
| Yes | 25 | 1.2 | 1.2 | 0.5 to 2.7 |
| No | 87 | 1.0 | 1.0 | – |
| Pressure algometry threshold* | | | | |
| <25th centile | 33 | 1.0 | 1.1 | 0.5 to 2.3 |
| ≥25th centile | 80 | 1.0 | 1.0 | – |
| Side of shoulder disorder | | | | |
| Dominant | 62 | 0.8 | 0.8 | 0.4 to 1.6 |
| Non-dominant | 51 | 1.0 | 1.0 | – |
| Repetitive work | | | | |
| Yes | 86 | 0.9 | 1.0 | 0.4 to 8.5 |
| No | 27 | 1.0 | 1.0 | – |
| Task cycle duration | | | | |
| <20 seconds | 69 | 1.4 | 1.0 | 0.5 to 2.1 |
| ≥20 seconds | 44 | 1.0 | 1.0 | – |
| Shoulder movements/minute† | | | | |
| >15 | 22 | 0.8 | 0.6 | 0.2 to 2.0 |
| ≤15 | 29 | 1.0 | 1.0 | – |
| Use of shoulder force$ | | | | |
| >10% of MVC | 18 | 08 | 0.5 | 0.1 to 2.3 |
| ≤10% of MVC | 33 | 1.0 | 1.0 | – |
| Perceived job demands | | | | |
| High (>75th centile) | 20 | 4.0 | 4.1 | 1.1 to 19.2 |
| Moderate (25th to ≤75th centile) | 77 | 1.8 | 1.8 | 0.5 to 6.1 |
| Low (≤25th centile) | 16 | 1.0 | 1.0 | – |
| Perceived job control | | | | |
| Low (≤25th centile) | 30 | 2.1 | 2.5 | 0.6 to 10.4 |
| Moderate (25th to ≤75th centile) | 69 | 1.6 | 1.8 | 0.5 to 6.3 |
| High (>75th centile) | 14 | 1.0 | 1.0 | – |
| Perceived social support | | | | |
| Low (≤25th centile) | 43 | 4.3 | 6.8 | 2.0 to 23.0 |
| Moderate (25th to ≤75th centile) | 44 | 2.3 | 3.1 | 0.9 to 10.1 |
| High (>75th centile) | 26 | 1.0 | 1.0 | – |

MVC, maximal voluntary contraction.
Centiles are based on the distributions in the source population.
*Adjustment for gender, age, right/left side tendonitis, intrinsic effort personality and algometric threshold (if appropriate: the analysis of risk attributable to gender was not "adjusted" for gender but for the other covariates, etc).
†Only including right sided shoulder tendonitis.

third (39 workers) still had identical symptoms and clinical signs from the same shoulder. The median duration of the first follow up interval was 346 days (11.5 months), with the 25–75th centile spanning 297 days (9.9 months) and 488 days (16.2 months). In recovered cases it is not known when in the interval the disorder subsided. If it is assumed that recovery on average took place at the middle of the interval, the survival function displayed in fig 1 indicates that some 50% had recovered within 10 months (95% CI 6 to 14 months) and 75% within 22 months (95% lower CI 15 months). These figures are not exact values. There was no difference in the rate of recovery of the dominant versus the non-dominant shoulder. The recovery rate was reduced in higher age and in workers who perceived high job demands, low job control (not significant), and low social support at the workplace (table 2). However, in the subset of workers that developed shoulder tendonitis during follow up, perception of job demands, control, and social support at baseline before the disorder was diagnosed were only weakly associated with persistence of shoulder tendonitis (data not shown). Repetitive work, degree of repetitiveness, and force requirements were not related to reduced recovery rate and only small changes of physical exposures were recorded during follow up (table 3). Nor were gender, psychological personality characteristics, or algometric pain threshold related to persistence of shoulder disorder.

Analyses of change of shoulder pain and disability symptoms during follow up, not taking clinical examinations and findings into account, did not reveal any consistent relation to individual factors, physical exposures, or perceived job characteristics, with the exception of higher age, which was clearly related to higher persistence of symptoms (data not shown).

## DISCUSSION
In this population based study of shoulder tendonitis it took some 10 months for 50% of cases to recover. Higher age was strongly related to slow recovery while physical job exposures were not. Perception of demands, control, and social support at the time when the shoulder disorder was diagnosed, were associated with delayed recovery, but these psychosocial factors did not predict slow recovery in incident cases identified during follow up.

Clinical series of shoulder tendonitis from hospital departments are skewed towards more severe disorders, and

**Table 3** Average exposure levels at onset and change from one round to the next in a follow up of 113 manual workers with shoulder tendonitis

| | Average exposure level at baseline, median (range) | No change, % | Increase, % | Decrease, % |
|---|---|---|---|---|
| Duration of manual tasks (cycle time, seconds) | 13.1 (2820) | 90.6 | 8.1 | 1.3 |
| Movements in shoulder/minute | 13.8 (36) | 81.2 | 10.1 | 8.7 |
| Force requirements in shoulder (scale 1–5, MVC) | 1.0 (3.0) | 91.9 | 4.7 | 3.4 |
| Perception of (score values 0–4) | | | | |
|     Job demands | 3.0 (3.0) | 64 | 12 | 24 |
|     Decision latitude | 2.9 (2.6) | 49 | 19 | 32 |
|     Social support | 2.0 (3.0) | 46 | 23 | 31 |

MVC, maximal voluntary contraction.
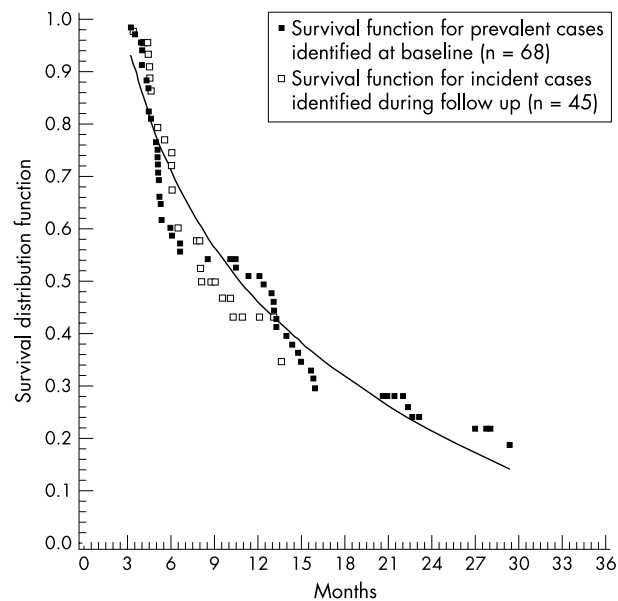


**Figure 1** Kaplan-Meier estimates of the survival function of shoulder tendonitis in 113 workers. Smoothing according to an exponential model based on least square regression on logarithmic transformed time values (prevalent and incident cases combined).

analyses of aetiological and prognostic factors may be distorted by selection bias. Although our population based approach bypassed this limitation, several other methodological problems need to be addressed. In the following we first discuss issues pertaining to participation rates, the time course of recovery, and then its relation to age and to physical and psychosocial job exposures.

More than 25% of the cross sectional sample of currently employed workers that were invited for the study declined to participate. The primary selection into the study presents a risk for bias if the non-participating sample includes cases with shoulder tendonitis, which are atypical with respect to the risk factors under study. If, for instance, workers with shoulder tendonitis, non-strenuous work, and fast recovery for some reason systematically refused to participate, the impact of strenuous work on the prognosis of shoulder disorders might be overestimated. However, physical risk factors turned out not to influence the duration of recovery and we have no reason to expect that selection into the study group has skewed or biased the findings.

When duration of recovery is defined by the time from diagnosis to the first follow up examination without symptoms and signs of shoulder disorder, the recovery time is systematically overestimated since recovery will have taken place at some unknown time between the two examinations. This was accounted for by selecting the median date of the

time interval spanning the last examination with shoulder disorder and the first examination without shoulder disorder as the date of recovery. Thus defined, the recovery time is too long for individuals recovering early in the interval but too short for individuals recovering late in the interval, but—assuming a constant recovery rate through the interval—the average recovery rate is unbiased. However, the recovery rate probably follows an exponential distribution with declining recovery rate through the interval. Moreover, shoulder tendonitis is a recurring disorder. Thus some cases may have recovered and recurred during the follow up interval. Accordingly our estimation procedure most likely results in too slow recovery rates and must be interpreted cautiously. A design with more close follow up examinations might produce a faster recovery rate. An unknown number of temporary shoulder complaints between examinations have not been identified, but this fact will hardly bias the estimate of recovery times of the diagnosed cases.

Since the intervals between follow ups varied between 6 and 18 months, the estimated recovery rate could largely depend on the distribution of follow up times. However, the follow up times for workers who recovered and workers that did not recover were identical in all three follow up intervals (for the first follow up: average interval among recovering workers 423 days (SD 24.3) and 419 days in workers that did not recover (SD 27.5), p >> 0.05).

Most cases were sampled at baseline and only 40% were incident cases identified during follow up. This is expected to length bias the sample towards a higher proportion of long term disorders that possibly have a poorer prognosis. However, the recovery rate only differed slightly between prevalent and incident cases. The duration of shoulder tendonitis can most often not be measured accurately since both onset and recovery may develop insidiously over several days or weeks. In our sample the duration was taken as the time interval between the dates, when the disorder was first diagnosed on the one hand and the median date of the round with the last verification of the disorder and the round when it had first disappeared on the other hand. The survival distribution functions were identical in baseline and follow up cases. This might reflect that the intervals between follow up examinations were in the range with the half life of the disorder (some 10 months). Accordingly the survival distribution represents the average duration of shoulder tendonitis as observed in a cross sectional sample.

Shoulder pain and clinical signs of tendonitis resolved in the majority of the workers, but continued for more than 18 months in some 25%. This sizeable proportion of workers with chronic pain and tenderness suggests that the disorder is not always a self limiting condition. We know little about tissue pathology in moderate and transient cases. Pain and tenderness are poorly related to ultrasonographic tears and magnetic resonance scanning anomalies.[19][20] The slow recovery at the higher age ranges could indicate a different pathology or type of disorder in the elderly worker. The ranges of passive

and active shoulder movements were markedly more reduced in elderly workers with tendonitis. Alternatively, the slow recovery with increasing age could simply reflect that tissue repair is slowed down at higher ages.

In earlier cross sectional analyses of the present study we have shown that high repetitiveness in combination with shoulder force requirements are related to a higher prevalence of shoulder tendonitis,[9] but the present data do not indicate that physical exposures influence the rate of recovery. Perhaps the natural history of this disorder takes its own course independent of physical working conditions. Alternatively, medical treatment, sick leave, and changes of workplace or work tasks during follow up could counteract detrimental effects of continued repetitive work. Although the task based extrapolation of physical job exposures was updated at each round of examination, this procedure could not be expected to be sensitive enough to catch changes in individual work practices.[11] Finally, the lack of association between physical exposure and rate of recovery could result from differential dropout. While the initial participation rate of 73% was in the range of the acceptable, only 67% of workers with shoulder tendonitis provided data for at least one follow up examination. Some of the cases lacking follow up data were diagnosed in the last round (26%) and this is not expected to distort the survival function. However, the severity of the disorder and job exposures might be of importance in the remaining cases. While pain reporting, shoulder strength, range of shoulder movements, and most work characteristics did not differ between workers with and without follow up, the average task cycle time was much higher in workers that dropped out (table 1). Therefore we conducted a worst case sensitivity analysis which included 45 subjects without follow up data but excluded 10 persons diagnosed during the last round of examinations. If the workers performed repetitive work at baseline, the shoulder tendonitis was assumed to persist in all cases (n = 34) and if not, to recover in all cases (n = 11). In this worst case analysis repetitive work was associated with no recovery of shoulder tendonitis (OR 2.4, 95% CI 1.2 to 2.4). Although it is unlikely that effects are strong, we cannot rule out that physical workplace exposures may modify the clinical course of shoulder tendonitis.

Perception of high job demands and low social support at the time of diagnosis was associated with a less favourable course of shoulder tendonitis—even when effects of other determinants were adjusted for. This may reflect the significance of options to adapt work tasks and the physical environment. However, perception of job demands and social support at the baseline examination was not associated with persistence of shoulder tendonitis in the subset of workers that developed the disorder during follow up. Therefore, perception of high job demands and low social support is most likely a consequence of the shoulder disorder rather than the opposite. Effects of work related psychosocial factors are not reported in the few other studies of long term outcome of shoulder tendonitis.[5 21–24]

In conclusion, the median duration of shoulder tendonitis in a cross sectional sample of industrial and service workers was some 10 months. Recovery was markedly reduced in higher age. Physical workplace exposures and perceived psychosocial job characteristics during the period preceding diagnosis seem not to be important prognostic factors.

## ACKNOWLEDGEMENTS

. . . . . . . . . . . . . . . . . . . .
## Authors' affiliations

**J P Bonde, J Baelum, S W Svendsen, P Frost, G Thomsen, E Overgaard,** Department of Occupational Medicine, Aarhus University Hospital, Denmark
**S Mikkelsen, J F Thomsen,** Department of Occupational Medicine, Copenhagen County Hospital, Glostrup, Denmark
**J H Andersen, A Kaergaard,** Department of Occupational Medicine, Herning Hospital, Denmark
**N Fallentin,** National Institute of Occupational Health, Copenhagen, Denmark

## REFERENCES

1 **Macnab I**. Rotator cuff tendinitis. *Ann R Coll Surg Engl* 1973;**53**:271–87.
2 **van der Windt DA**, Koes BW, de Jong BA, *et al*. Shoulder disorders in general practice: incidence, patient characteristics, and management. *Ann Rheum Dis* 1995;**54**:959–64.
3 **Kaergaard A**, Andersen JH. Musculoskeletal disorders of the neck and shoulders in female sewing machine operators: prevalence, incidence, and prognosis. *Occup Environ Med* 2000;**57**:528–34.
4 **Chard MD**, Sattelle LM, Hazleman BL. The long-term outcome of rotator cuff tendinitis—a review study. *Br J Rheumatol* 1988;**27**:385–9.
5 **Cole DC**, Hudak PL. Prognosis of non-specific work-related musculoskeletal disorders of the nek and upper extremity. *Am J Ind Med* 1996;**29**:657–68.
6 **Jonsson BG**, Persson J, Kilbom Å. Disorders of the cervicobrachial region of female workers in the electronics industry. *Int J Ind Ergon* 1988;**3**:1–12.
7 **van der Windt DA**, Koes BW, Boeke AJ, *et al*. Shoulder disorders in general practice: prognostic indicators of outcome. *Br J Gen Pract* 1996;**46**:519–23.
8 **Winters JC**, Sobel JS, Groenier KH, *et al*. The long-term course of shoulder complaints: a prospective study in general practice. *Rheumatology (Oxford)* 1999;**38**:160–3.
9 **Frost P**, Bonde JP, Mikkelsen S, *et al*. Risk of shoulder tendinitis in relation to shoulder loads in monotonous repetitive work. *Am J Ind Med* 2002;**41**:11–18.
10 **Kaergaard A**, Andersen JH, Rasmussen K, *et al*. Identification of neck-shoulder disorders in a 1 year follow-up study. Validation of a questionnaire-based method. *Pain* 2000;**86**:305–10.
11 **Fallentin N**, Juul-Kristensen B, Mikkelsen S, *et al*. Physical exposure assessment in monotonous repetitive work—the PRIM study. *Scand J Work Environ Health* 2001;**27**:21–9.
12 **Harrington JM**, Carter JT, Birrell L, *et al*. Surveillance case definitions for work related upper limb pain syndromes. *Occup Environ Med* 1998;**55**:264–71.
13 **Pope DP**, Croft PR, Pritchard CM, *et al*. Prevalence of shoulder pain in the community: the influence of case definition. *Ann Rheum Dis* 1997;**56**:308–12.
14 **Winters JC**, Sobel JS, Groenier KH, *et al*. A shoulder pain score: a comprehensive questionnaire for assessing pain in patients with shoulder complaints. *Scand J Rehabil Med* 1996;**28**:163–7.
15 **Karasek R**, Baker D, Marxer F, *et al*. Job decision latitude, job demands, and cardiovascular disease: a prospective study of Swedish men. *Am J Public Health* 1981;**71**:694–705.
16 **Siegrist J**, Peter R. *Measuring effort-reward imbalance at work: guidelines*. Dusseldorf Germany: University of Dusseldorf, 1996.
17 **SAS Institute Inc**. *SAS user's guide: statistics, version 5*. Cary NC: SAS Institute Inc., 1986.
18 **Scheike TH**, Jensen TK. A discrete survival model with random effects: an application to time to pregnancy. *Biometrics* 1997;**53**:318–29.
19 **Teefey SA**, Hasan SA, Middleton WD, *et al*. Ultrasonography of the rotator cuff. A comparison of ultrasonographic and arthroscopic findings in one hundred consecutive cases. *J Bone Joint Surg Am* 2000;**82**:498–504.
20 **Tempelhof S**, Rupp S, Seil R. Age-related prevalence of rotator cuff tears in asymptomatic shoulders. *J Shoulder Elbow Surg* 1999;**8**:296–9.
21 **Chard MD**, Sattelle LM, Hazleman BL. The long-term outcome of rotator cuff tendinitis—a review study. *Br J Rheumatol* 1988;**27**:385–9.
22 **Houtman IL**, Bongers PM, Smulders PG, *et al*. Psychosocial stressors at work and musculoskeletal problems. *Scand J Work Environ Health* 1994;**20**:139–45.
23 **Toomingas A**, Theorell T, Michelsen H, *et al*. Associations between self-rated psychosocial work conditions and musculoskeletal symptoms and signs. Stockholm MUSIC I Study Group. *Scand J Work Environ Health* 1997;**23**:130–9.
24 **Westgaard RH**. Effects of physical and mental stressors on muscle pain. *Scand J Work Environ Health* 1999;**25**(suppl 4):19–24.