THE EFFECT OF PAIN REDUCTION ON PERCEIVED TENSION AND 
EMG-RECORDED TRAPEZIUS MUSCLE ACTIVITY IN WORKERS 
WITH SHOULD ER AND NECK PAIN

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and 2Trondheim Physiotherapy Clinic, Trondheim, Norway

ABSTRACT. The study was initiated to evaluate the 
effect of pain-reducing therapies on factors previously 
associated with work-related shoulder and neck pain, 
namely increased muscle activity in the upper trapezius 
and perceived general tension. Thirty-three women 
in three groups were assessed before and after an inter-
vention period and by questionnaire 6 months later. The 
purpose of this study was primarily to investigate 
associations between upper trapezius muscle activity, 
perceived general tension and pain, and secondly, to 
compare effects of individually based physiotherapy 
and group exercise for workers with shoulder and 
neck myalgia. All three groups reported a significant 
 alleviation of pain and perceived general tension, while 
the electromyographically (EMG) recorded upper 
trapezius muscle activity level remained unchanged or 
increased. Improvements were similar in all three 
treatment groups, but individual-based therapies were 
rated more beneficial on subjective measures. Signifi-
cant correlation was found between pain and perceived 
general tension (r = 0.66, p < 0.01), while there was no 
correlation between pain or perceived general tension 
and recorded muscle activity.

Key words: shoulder myalgia, pain, muscle tension, musculo-
skeletal, work-related, intervention, electromyography, phy-
siotherapy.

INTRODUCTION

Recent studies at our laboratory indicated that 
different and independent mechanisms may be 
involved in the development of apparently work-
related shoulder and neck myalgia. Variables related 
with psychological, psychosomatic and psychosocial 
factors were associated with pain in one work group, 
whereas weak or no such associations were found in 
another work group (24). In the latter group, 
however, pain was related to increased upper 
trapezius muscle activity, as measured by surface 
EMG both during work and in test situations. No 
such association was found for the former group (22). 
There was weak or no association between these two 
groups of variables, thus indicating an independence 
of these two factors as risk indicators of shoulder and 
neck pain (23). Increased self-reported or perceived 
general tension was however closely related to pain in 
both work groups, and it was the only variable besides 
headache found to be related to shoulder and neck 
pain in both work groups.

These findings evoked an interest in investigating 
whether these variables could be influenced by 
successful intervention procedures. In particular, 
whether perceived general tension and recorded 
muscle activity can be attributed to the individual's 
'trait' or 'state', i.e. related to permanent personality 
characteristics ('trait') or reflecting present circum-
stances or conditions ('state'), such as pain status. 
Perceived tension has been shown to correlate with 
psychological states, psychosomatic symptoms, psy-
chosocial factors, and pain in cross-sectional studies 
(18, 23), indicating that this variable may be related to 
both 'trait' and 'state'. However, it has been found 
difficult to show a relationship between perceived 
general tension and recorded muscle activity (23). 
The effect of pain alleviation on perceived general 
tension and on recorded muscle activity has not 
been investigated.

Various exercise therapies have been investigated 
for work-related muscle pain originating in the 
shoulder and neck area. A cross-over design with 
group gymnastics at the work place for neck pain 
showed no clear effect (17). Strength training during 
orinary working hours for 30 min three times a week 
for 3 months was found to be superior to general 
exercise for 30 min once a week in terms of increased
Table 1. Mean age and employment time in current job for all three groups

<table>
<thead>
<tr>
<th>Group 1</th>
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<td>n = 12</td>
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</tr>
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</table>

Age (yrs) | 39.7 (22-49) | 38.1 (25-50) | 29.7 (16-23) |
Employment time (yrs) | 15.0 (6-20) | 13.4 (5-26) | 5.7 (1-15) |

METHODS

Subjects and study design

Twenty-four female office workers with shoulder and neck pain agreed to participate in the study and were randomized to either active therapy (n = 12) or group exercise (n = 12). All subjects included in these groups had experienced shoulder and neck pain at some point in the previous 2 weeks and had experienced pain for at least 2 days daily during the last 2 weeks before baseline. Thirteen of these subjects were recruited from the cases participating in a recent one-control study (22, 24). All were fully employed during the intervention period. In...
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The study was initiated to investigate whether physiological parameters and subjectively reported risk factors identified in a cross-sectional study were affected by intervention procedures aimed at reducing pain in the shoulder and neck region. The primary purpose was to study associations between recorded muscle activity in the upper trapezius, self-reported or perceived general tension, and pain, when the pain was manipulated by intervention procedures.

The study also reported comprehensive results of individually based physiotherapeutic treatment regimes and group exercise for work-related shoulder and neck myalgia.

**METHODS**

**Subjects and study design**

Twenty-four female office workers with shoulder and neck pain agreed to participate in the study and were randomized to either a treatment group (n = 12) or group exercise (n = 12). All subjects included in these groups had experienced shoulder and neck pain at or above 3 on a pain rating scale from 0 to 10 (27), both during the previous 6 months and at least 3 days continuously during the last 2 weeks before testing. These subjects were recruited from the cases participating in a recent one-centre control study (24, 26). All were fully employed during the intervention period.

As an additional group of female patients (n = 9) with shoulder and neck pain, and with presumably more severe symptoms, was recruited from local physiotherapists and included to strengthen the power of the study. The inclusion criteria for these patients were more stringent, and included pain in the upper trapezius region during the last 2 weeks, at least one active trigger point in the upper trapezius muscle, and pain upon passive stretching of the upper trapezius. These assessments were made by the treating physiotherapist, and later crosschecked by the laboratory. Exclusion criteria for all groups were shoulder and neck pain due to trauma or systemic disease, pregnancy, diag- nosed rheumatism, or ongoing use of medication of the cervical spine.

There was no difference between groups with regards to working hours, nor was there any difference in age or duration of employment between groups 1 and 2, but group 3 were significantly younger and had been employed for a significantly shorter period of time than the subjects in the other two (Table 1). During the year prior to inclusion, group 2 had shorter contacts with the public health service, sick leave and treatments due to shoulder and neck pain than the other two groups, but there was no difference in perceived pain levels between the groups during the same time period.

**Intervention**

**Individual physiotherapy (group 1):** The subjects were treated by a local physiotherapist at a physiotherapy clinic outside the workplace twice a week and given a total of 16 treat- ments. Each treatment lasted for approximately 40 min and included therapies for the shoulder and neck muscles as follows; massage (5-10 min), strength and flexibility exer- cises (20-30 min), stretching (5-10 min) and heat treatment on apparatus (5-10 min). Passive mobilization of the cervical spine was performed when indicated. Ergonomic principles were emphasized and communicated to subjects during exercises between sessions. Subjects were encouraged to perform home exercises on a postural control, and on strength and flexibility training of the shoulder and neck region was handed out and encouraged.

**Group exercise (group 2):** The group sessions were performed at the workplace in the morning three times a week for 6 weeks. The therapy sessions were adapted from a recent publication by Dysart et al. (3), who found good effects of this regime, with increased strength in shoulder and neck muscles and reduced pain. The exercises are described in detail in the study by Dysart et al. With 1.1 kg dumb-bells in both hands, four arm exercises were performed 10 times each. The exercise cycle was repeated three times. For some individuals the load had to be adjusted early in the treatment period. To avoid overloading in the early pe- riod, in short sessions between exercises, the subjects exercised only muscles of the abdomen and back, practiced correct breath- ing techniques, and were informed by the physiotherapist of ergonomic principles, e.g., the need to keep only one hand of group 1, and the necessity of controlling the hand when performing the exercise. Each session ended with isometric stretching exercises for muscles in the shoulder and neck region.

**Effect of pain reduction on perceived general tension and measured muscle activity.** The subjects received an average of 12 (range 8-17) treatments.

**Effect variables**

The subjects were evaluated on the complete set of variables before and during treatment period, while a questionnaire on subjectively experienced symptoms was mailed to the subjects in groups 1 and 2 at follow-up 6 months after the second evaluation. Pain was obtained before and after the treatment period on the following variables.

**Ergonomic EMG measurements:** Surface EMG was used to quantify trapezius muscle activity. Integral, integrated instantaneous (IA) and (IA) 4-s isometric trapezius muscles, in diameter and with a 20-mm inter-electrode distance, were used. The centres of the electrodes were placed at a point (23) between the distance from the spine of the seventh cervical vertebra (C7) and the lateral edge of the acromion (11). The system noise level with the electrodes on inert biological material was 1.5 lmV RMS, corresponding to 0.15% of the signal amplitude at maximal voluntary contraction. This was then equal to the lowest observed EMG level during muscle relaxation. The noise level was estimated for each subject by histograms from the calibration procedure, and then subtracted from the test recordings before full-wave rectification and averaging over intervals of 0.2 s was performed. The EMG method has been described in detail previously (22).

EMG calibrations were carried out before and after the test recordings. Maximal contractions were performed both in shoulder elevation ("shrug") and in 90° arm abduction (11). The contraction that produced the highest EMG amplitude for 5-s was used as the basis for the EMG calibration procedure (N450μV). EMG test recordings: The muscle coordination or arm movement test and the muscle activity of the passive and active trapezius while moving the arm of hand dominance. In the test the dominant arm and hand was required to move between three target areas (circles of 20 mm in diameter), as indicated by button presses placed in front of the subject. Apart from the shoulder and neck muscles, those involved in the movement of body during the test. EMG test procedure: The test was designed to quantify resting muscle activity in the upper trapezius. The test was divided into the "active muscle test" and the "rest test," the subjects were instructed to perform 5 tasks while seated at a desk and 3 tasks while standing. The tasks were performed continuously, each lasting 30 s, separated by 30 s rest periods. The hands were placed on a 10 s rest period. The hands were placed on a VDU-users who performed two-scaled test and differences were considered significant if less than the 5% confidence level. These results were expressed as mean values with 95% confidence intervals.

**Pearson product moment for normalized data** 5 min of s-tensor for post hoc analyses. Student's paired t-test was then used for parametric data and Wilcoxon signed-ranks test for nonparametric data to test differences within group differences. The Mann-Whitney U-test was used to test between group differences. Comparisons were performed two-tailed and differences were considered significant if less than the 5% confidence level. These results were expressed as mean values with 95% confidence intervals. An agreement index of 90% is considered the lower limit of the 95% agreement between two measurements or methods, while lower positive values indicate decreasing agreement, with negative value means that the size of the 95% agreement limits is larger than the mean of the two measurements, which is usually regarded as poor agreement.
RESULTS

Compliance with the treatment regime was good for both groups 1 and 2: 92% and 96%. There were no drop-outs. The compliance rates are estimated on the basis of the total number of treatment sessions offered in each group. Two subjects in group 1 and 5 in group 2 did not carry out the home exercises nor performed any other form of exercise during the intervention period.

Intervention

Pain and perceived general tension: The pain level in test 1, expressed as the average pain level for the past week on a VAS, was almost identical for groups 1 and 2, and considerably higher although not significant for group 3 (Fig. 1A). All groups showed a marked reduction in pain level from test 1 to test 2 ($p<0.05$). Similar results were seen for perceived general tension, which decreased significantly in all groups from test 1 to test 2 ($p<0.05$, Fig. 1B). The reduction of both pain and perceived general tension was largest in group 3. There was no difference between the two intervention procedures, i.e. group 1 vs. group 2. There was a significantly larger decrease in perceived general tension for group 3, both when compared with group 1 ($p<0.05$) and vs. group 2 ($p<0.05$).

Muscle activity: The muscle activity levels during the mentally-demanding attention test were mostly unchanged from test 1 to test 2 in group 1, and showed a non-significant tendency to increase in groups 2 ($p=0.07$) and 3 ($p=0.10$, Fig. 3A). In other words, the intervention procedures did not lead to reduced muscle activity levels for any of the groups. In fact, a significant increase in the muscle activity level was found when all three groups were analysed together ($p=0.02$). There was no change in the muscle activity levels on the active side during the arm movement test, and virtually identical levels were found in tests 1 and 2 for all three groups (Fig. 3B). Group 3 had a consistently lower muscle activity level in this test, compared with the other two groups. Results from the recordings of the EMG testing levels and the arm movement test on the passive side were consistent with the results for the trapezius on the active side in the movement test.

Strength: Strength in shoulder elevation was recorded in group 3 only. A marked, but insignificant increase in strength was found from test 1 to 2. The average strength level increased by almost 20% from test 1 (45.4 kg; CI 33.4–57.4) to test 2 (54.0 kg; CI 44.1–64.0). The result may well have reached statistical significance with a larger sample size (Type 2 error).

A weak negative correlation between strength and pain the previous week ($r=−0.44$, $p=0.07$) was found when test 1 and 2 were pooled.

Trigger points: A successful reduction of trigger point sensitivity of the TP1 of the upper trapezius was seen in all three groups following the intervention procedures (Table II). No effect was found on the number of trigger points in the upper trapezius muscle nor on the total number of trigger points (Table II), with the exception of total number of trigger points in group 3. The individual variability was large, however, and not all subjects presented an active trigger point in TP1 of the upper trapezius.

Follow-up and subjective assessments: A questionnaire was mailed to the office workers (group 1 and 2) 6 months after test 2. The average reported pain levels during the previous week (median value with 95% CI) as measured on the same VAS scale as used in tests 1 and 2, were 2.4 (0.4–3.9) and 2.9 (0.2–4.1) for groups 1 and 2, respectively. Similarly, the perceived general
**RESULTS**

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**Intervention**

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Daily pain levels were recorded by the subjects in groups 1 and 2 throughout the intervention period (Fig. 2). A steady decrease was seen for both groups, with a larger decrease for the group receiving individual physiotherapy ($p < 0.01$).

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**Strength:** Strength in shoulder elevation was recorded in group 3 only. A marked, but insignificant increase in strength was found from test 1 to 2. The average strength level increased by almost 20% from test 1 (45.4 kg, CI: 33.6–57.1) to test 2 (54.0 kg, CI: 44.1–64.6). The result may well have reached statistical significance with a larger sample size (Type 2 error). A weak negative correlation between strength and pain the previous week ($r = -0.44$, $p = 0.07$) was found when test 1 and 2 were pooled.

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Table II. Trigger point sensitivity (kg; mean of left and right trapezius), number of trigger points in left and right trapezius (max. 4), and total number of trigger points (max. 18) in all three groups before (test 1) and after (test 2) the intervention period

<table>
<thead>
<tr>
<th>Trigger point sensitivity (kg)</th>
<th>p</th>
<th>Number of trigger points in trapezius</th>
<th>p</th>
<th>Total number of trigger points</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test 1</td>
<td></td>
<td>1.0 (0.7–1.3)</td>
<td>0.04</td>
<td>2 (1–4)</td>
<td>0.23</td>
</tr>
<tr>
<td>Test 2</td>
<td></td>
<td>1.0 (1.2–4.0)</td>
<td>0.04</td>
<td>1 (0–4)</td>
<td>0.74</td>
</tr>
<tr>
<td>Group 2</td>
<td></td>
<td>1.0 (0.6–4.0)</td>
<td>0.02</td>
<td>2 (0–3)</td>
<td>0.11</td>
</tr>
<tr>
<td>Test 1</td>
<td></td>
<td>1.0 (0.2–4.0)</td>
<td>0.02</td>
<td>2 (0–3)</td>
<td>0.11</td>
</tr>
<tr>
<td>Test 2</td>
<td></td>
<td>4.0 (1.0–4.0)</td>
<td>0.02</td>
<td>2 (0–3)</td>
<td>0.11</td>
</tr>
</tbody>
</table>

A maximum value of 4 kg is given to all with no radiant pain. Lower values indicate increased sensitivity to pressure.

tension level was 3.8 (1.8–6.7) for group 1 and 5.0 (1.8–6.9) for group 2. This indicates that the effects seen after the intervention period (see Fig. 1A,B) were maintained to a certain extent, more so in group 1 than 2. This was also reflected in the subject's own judgment of effect, where 75% (9/12) at the end of treatment and 60% (6/10) at follow-up regarded themselves much better or painfree in group 1. In group 2, the corresponding values were 17% (2/12) and 25% (3/12) (Table III). There was no difference in exercise frequency between the groups in the same period.

Four subjects in group 1 and 2 subjects in group 2 made contact with the health care system due to shoulder and neck pain in the follow-up period. In general terms, there was a tendency towards a slightly better outcome on subjective judgements for group 1 as compared with group 2, both at the end of treatment and at follow-up. Those that kept exercising during the follow-up period regardless of treatment group reported lower mean pain (1.82) and increased general tension (3.50) at follow-up than those who did not exercise (3.45 and 4.47, respectively). However, these differences were also present in test 1 (3.49 vs. 5.0 for pain and 5.38 vs. 7.86 for perceived general tension) and test 2 (1.45 vs. 2.88 for pain and 2.67 vs. 3.76 for perceived general tension).

Risk indicators

Measured muscle activity, pain and perceived general tension: No significant correlations were seen between trapezius activity in the active arm during the movement test and perceived general tension (Fig. 4A), nor between trapezius activity in the active arm during the movement test and pain the previous week (Fig. 4B). This was the case when all individual results from tests 1 and 2 were analysed collectively, for tests 1 and 2 separately, and for each treatment group (test 1 and 2 together). Nor were there any correlations between pain or perceived general tension and any of the other EMG variables.

Table III. Subjective judgement of pain status at end of treatment and at 6 months follow-up, compared with before treatment

<table>
<thead>
<tr>
<th>Frequency counts (number of subjects) are given.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1 (n = 12)</td>
</tr>
<tr>
<td>End of treatment (Follow-up)</td>
</tr>
<tr>
<td>Worse</td>
</tr>
<tr>
<td>No change</td>
</tr>
<tr>
<td>Slightly better / No pain</td>
</tr>
<tr>
<td>Much better / Pain free</td>
</tr>
<tr>
<td>Group 2 (n = 12)</td>
</tr>
<tr>
<td>End of treatment (Follow-up)</td>
</tr>
<tr>
<td>Worse</td>
</tr>
<tr>
<td>No change</td>
</tr>
<tr>
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Fig. 4. Correlation between trapezius activity during the arm movement test for the active side and perceived general tension (A), and pain during the week prior to the evaluation (B) for tests 1 and 2, and correlation between pain during the week prior to the evaluations and perceived general tension (C) for tests 1 and 2. See Fig. 1 for phrasing of VAS anchor points.

There were no indications that the intervention procedures or the pain reduction affected the maximal EMG levels (i.e., performed during the EMG calibrations). Close correlations between tests 1 and 2 with nearly identical mean levels were found both for the right (r = 0.81, p < 0.001 and Al = 0.66) and left (r = 0.57, p < 0.001 and Al = 0.59) side.

Pain and perceived general tension: A significant correlation was found between pain and perceived general tension when results from tests 1 and 2 for all three groups were pooled (r = 0.66, p < 0.01). The best correlation was found for the lower score levels seen in test 2 (r = 0.72, p < 0.001), while there was no significant correlation between perceived pain and perceived general tension in test 1 (r = 0.31, p = 0.10). Intermediate score levels were seen in test 3 (at follow-up; groups 1 and 2 only), with a relatively good correlation between the two variables (r = 0.62, p < 0.01).

Measured muscle activity (EMG): There was no significant correlation between tests 1 and 2 for the muscle activity level in the attention test (r = 0.18, p = 0.32), while consistent results were seen between tests 1 and 2 for the active side movement test (r = 0.83, p < 0.001, Al = 0.07). This indicates that the latter test, although not affected by the intervention procedure, had a fairly high test–retest reliability. Significant correlation between tests 1 and 2 was also seen for resting tension in standing (r = 0.65, p < 0.001), but not in sitting (r = 0.28, p = 0.12).

DISCUSSION

Variables reflecting the subjects' perceived general tension and pain were successfully reduced in this study by all intervention procedures, while measured muscle activity remained unchanged in the tests applied. The only exception was a tendency to higher muscle activity level after pain alleviation for the attention test, which was statistically significant only when results from all three groups were pooled. Similar effects were seen for all three treatment groups. In terms of pain alleviation, individual physiotherapy was rated more favourably by the subjects than group exercise. No relationship was found between physiological measurements of muscle activity in the upper trapezius muscle and subjective assessments like perceived general tension and pain in the shoulder and neck area. High test–retest reliability between test 1 and test 2 was found for the recordings of trapezius activity on the active side in the movement test. Perceived general tension has been shown to
Table II. Trigger point sensitivity (kg; mean of left and right trapezius), number of trigger points in left and right trapezius (max. 4), and total number of trigger points (max. 18) in all three groups before (test 1) and after (test 2) the intervention period

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<th>p</th>
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<tbody>
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A maximum value of 4kg is given to all with no radiating pain. Lower values indicate increased sensitivity to pressure.

The effect of pain reduction on perceived general tension

Table III. Subjective judgement of pain status at end of treatment and at 6 months follow-up, compared with before treatment

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<td>Follow-up</td>
</tr>
<tr>
<td>Worse</td>
<td>0</td>
</tr>
<tr>
<td>No change</td>
<td>1</td>
</tr>
<tr>
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<td>3</td>
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<tr>
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Pain and perceived general tension: A significant correlation was found between pain and perceived general tension when results from tests 1 and 2 for all three groups were pooled (r = 0.66, p < 0.01). Fig. 4C. The best correlation was found for the lower score levels seen in test 2 (r = 0.72, p < 0.001), while there was no significant correlation between perceived pain and perceived general tension in test 1 (r = 0.31, p = 0.10). Intermediate score levels were seen in test 3 (at follow-up; groups 1 and 2 only), with a relatively good correlation between the two variables (r = 0.62, p < 0.01).

Measured muscle activity (EMG): There was no significant correlation between tests 1 and 2 for the muscle activity level in the attention test (r = 0.18, p = 0.32), while consistent results were seen between tests 1 and 2 for the active side movement test (r = 0.83, p < 0.001, AI = 0.70). Fig. 5A,B. This indicates that the latter test, although not affected by the intervention procedure, had a fairly high test-retest reliability. Significant correlation between tests 1 and 2 was also seen for resting tension in standing (r = 0.65, p < 0.001), but not in sitting (r = 0.28, p = 0.12).

DISCUSSION

Variables reflecting the subjects' perceived general tension and pain were successfully reduced in this study by all intervention procedures, while measured muscle activity remained unchanged in the tests applied. The only exception was a tendency to higher muscle activity level after pain alleviation for the attention test, which was statistically significant only when results from all three groups were pooled. Similar effects were seen for all three treatment groups. In terms of pain alleviation, individual physiotherapy was rated more favourably by the subjects than group exercise. No relationship was found between physiological measurements of muscle activity in the upper trapezius muscle and subjective assessments like perceived general tension and pain in the shoulder and neck area. High test-retest reliability between test 1 and test 2 was found for the recordings of trapezius activity on the active side in the movement test. Perceived general tension has been shown to...
correlate with personality and psychosocial variables, and with work-related shoulder and neck pain (23, 24). The fact that perceived general tension was markedly reduced by the intervention procedures, favours the notion that this variable largely reflects transient circumstances (i.e. 'state') rather than persistent personality characteristics (i.e. 'trait'). The variable may thus serve as an indicator of risk for developing work-related shoulder and neck pain and as an outcome variable in measurements of treatment effect. The correlation found between this variable and pain might suggest that these two variables can be used interchangeably. However, the correlation was poor for the higher pain and perceived tension levels as in the pre-intervention situation, which was also the case for the larger material in the case control study (r = 0.19, p = 0.24). The two variables should therefore be treated as interrelated, but separate.

Surface EMG recordings of the upper trapezius activity both during work and in test situations have been used to examine a possible correlation between muscle activity and muscle pain, with mixed results (10, 22, 23). Increased muscle activity in the upper trapezius in subjects with work-related myalgia has been reported during the relaxation phase of repetitive arm flexion movements as compared with healthy controls (4). Active relaxation training has been shown to reduce the trapezius EMG activity level both in test situations and during work (20). In the present study, pain and perceived general tension were reduced without a concurrent reduction in recorded muscle activity levels. This result may be influenced by the fact that muscle load at work and in laboratory tests for the office workers (i.e., groups 1 and 2) in the present study did not differentiate between workers with shoulder and neck pain and their matched, painfree controls, as reported previously (22). The EMG results in the present study might have been different if a group of workers with deviated muscle activity compared with healthy controls had been selected (5, 22). Vocational EMG recordings would probably not have changed these results, as EMG activity on the active side in the movement test has been found to correlate well with muscle activity during work (22, 28).

This study corroborates the positive effects of physiotherapy, with emphasis on strength training, in reducing work-related shoulder and neck pain, as reported by Dyssen et al. (3). Increased strength, range of motion and endurance along with alleviated pain or discomfort have been reported in several studies (3, 9, 12, 13). Aerobic exercise was superior to stress management in alleviating muscle pain in insurance office workers (8). Exercise breaks during working hours have been shown to reduce musculoskeletal discomfort and to increase productivity (19). A critical remark to our study design in evaluating the effects of the intervention procedures is the lack of a control group. Nevertheless, as many as 75% of the office workers in the individual physiotherapy group reported positive effects of the intervention procedure, well above commonly accepted placebo effects. However, controlled studies are still warranted.

The positive effects of exercise found in study groups 1 and 2 were partially maintained at 6 months' follow-up, at least for group 1 (individual physiotherapy). This happened despite the fact that only about half of the subjects in both groups continued exercising on their own on a regular basis in the follow-up period. These results are contradicted by others who have found that the effects of exercise are lost upon ceasing training (7, 13). It appears that those who kept exercising in the follow-up period, as opposed to those who did not, reported lower pain and perceived general tension levels 6 months after the intervention period. The interpretation of this result is uncertain, since similar differences were also present in tests 1 and 2. It might indicate heterogeneous personality characteristics, indicating that inactive individuals are more likely to report complaints, or that those who report more pain are less likely to exercise.

A successful reduction of trigger point sensitivity (i.e., increased pain threshold) was found for all three groups in our study. This is in agreement with another study (14) which found that pain pressure thresholds in the trapezius muscle were significantly lower in workers with high complaints of shoulder and neck pain as opposed to those with low complaints. In that study, the effects of treatment with the highest pain levels showed lower EMG amplitudes during work than the subjects with lower reported pain. These results add more support to the notion that the level of vocational EMG muscle activity is a poor predictor of musculoskeletal complaints, at least for groups with low biomechanical demands at work.

In conclusion, no correlation was found between upper trapezius muscle activity and shoulder and neck pain or perceived general tension. Good test-retest reliabilities were seen for some of the EMG variables. A marked reduction in pain and perceived general tension was seen in all three intervention groups in this study, while no effect or a slight increase in recorded muscle activity in laboratory tests were seen during the same period. Individually based outpatient physiotherapy and group exercise at the workplace were approximately equally effective in alleviating pain and perceived general tension. The former group was however more satisfied with the intervention effects on their health status, and they also seemed to maintain this improvement better at 6 months' follow-up than the subjects participating in the group exercise regime.

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LETTER TO THE EDITOR

INTERRATER RELIABILITY OF THE 7-LEVEL FUNCTIONAL INDEPENDENCE MEASURE (FIM)

Sir,

The interrater reliability study by Hamilton et al. (1) of the 7-level functional independence measure contains possible sources of bias in the clinical assessments, inadequate statistical descriptions of its results, and lacks evidence to support its conclusions.

The study abstract contains a description of results that does not reflect the actual methodology.

Hamilton et al. reported on the interrater reliability in the clinical setting, asking two clinicians in each participating facility "to make their patient FIM assessments on the same day during the patient's first rehabilitation admission and not to discuss their findings with each other". They then state that "most of the items were assessed by the disciplines usually assigned to evaluating a given functional area. For example, occupational therapists were likely to assess eating... physical therapists, ambulation... and social: nursing, bowel and bladder". Therefore, each patient has not necessarily been rated by two clinicians, but perhaps by two groups of clinicians.

If the assessment was carried out by groups, mechanisms must have been necessary to ensure that consultation did not occur, but these are not described, apart from the instruction that the clinicians not discuss their findings with each other.

The method of assessment of the patients is not described. Ideally, an inter-rater reliability study should have the two assessors assessing the one performance by the subject at the same time. It is not known if the assessments were performed on one or two different occasions on the same day, raising the possibility of inter-rater bias, especially important when considering the fluctuating daily functional performance in some patients with neurological conditions.

Because of the lack of information about the setting of assessments, the number of participants in the study at the various institutions involved, the times at which the assessments were made, and the information given to the patients undergoing assessment, we may assume that uniform conditions did not prevail across the study.

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The study consists of 89 separate studies by two, or perhaps more assessors, of at least 10 different patients, with no two studies involving the same patients. This is a less than adequate methodology for a formal study of reliability, as the confidence interval for intraclass correlation coefficients based on 10 patients would be unacceptable wide. Eighty-nine separate studies of 10 different patients each is not the equivalent of one study of 890 patients (or 3018 patients).

While Hamilton et al. (2) admit that intraclass correlation coefficients are not recommended for assessing reliability at the nominal or ordinal level, they present us with a group of averaged intraclass correlation coefficients for FIM total, domain and subdomain scores. Ordinal data from FIM when summed do not become interval data, and these intraclass coefficients are, in our opinion, lacking in meaning, quite apart from lacking a confidence interval.

No range or variance of Kappa coefficients was presented. No test of significance of Kappa could be presented, presumably because of the small number of patients in each of the 89 studies. It is possible that the range of Kappa coefficients in this study included values lower than 0.4. The fact that one of the criteria for inclusion in a “criterion facility”, was “15 of 18 items with a Kappa greater than 0.45” indicates the strong likelihood of this situation. If any of these lowest values were taken as evidence of reliability, the FIM would not be an acceptable measure. There is no reason, of course, given the nature of this study, for a high Kappa to be more acceptable than a low Kappa, as neither may have been greater than a value expected by chance.

No information is given as to the test procedures used to establish the criterion facilities were decided. If the criteria were decided post hoc, it seems self-evident that those meeting the criteria had high inter-rater reliability scores, as setting lower limits for cut-off scores for inclusion in aggregated statistics results in a higher average for those