

Effect of Two Contrasting Types of Physical Exercise on Chronic Neck Muscle Pain

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Objective. The prevalence of neck muscle pain has steadily increased and especially pain from the descending part of the trapezius muscle has been associated with monotonous work tasks such as computer work. Physical exercise is generally recommended as treatment, but it is unclear which type of training is most effective. Our objective was to determine the effectiveness of specific strength training of the painful muscle versus general fitness training without direct involvement of the painful muscle (leg bicycling) on work-related neck muscle pain.

Methods. We conducted a randomized controlled trial and recruited subjects from 7 workplaces characterized by monotonous jobs (e.g., computer-intensive work). Forty-eight employed women with chronic neck muscle pain (defined as a clinical diagnosis of trapezius myalgia) were randomly assigned to 10 weeks of specific strength training locally for the affected muscle, general fitness training performed as leg bicycling with relaxed shoulders, or a reference intervention without physical activity. The main outcome measure was an acute and prolonged change in intensity of neck muscle pain (100-mm visual analog scale [VAS]).

Results. A decrease of 35 mm (~79%; $P < 0.001$) in the worst VAS pain score over a 10-week period was seen with specific strength training, whereas an acute and transient decrease in pain (5 mm; $P < 0.05$) was found with general fitness training.

Conclusion. Specific strength training had high clinical relevance and led to marked prolonged relief in neck muscle pain. General fitness training showed only a small yet statistically significant acute pain reduction.

INTRODUCTION

Musculoskeletal disorders comprise one of the most common and costly public health problems in North America and Europe today (1), with an estimated cost between 0.5% and 2% of the Gross National Product (2). In particular, the prevalence of neck pain has been steadily increasing through the past 2 decades (3), and is now second to back pain, the most common musculoskeletal disorder (4,5). More than half of all adults have experienced neck pain during the past 6 months, and women are more likely

than men to develop and suffer from persistent neck pain (6–8). Still actively employed, these women experience sensations of localized muscle pain, tenderness at palpation, stiffness, and constant muscle fatigue (9,10). In particular, computer work has been associated with neck symptoms (11), and more specifically pain from the descending part of the trapezius muscle, or trapezius myalgia, is frequent in women engaged in repetitive and monotonous work tasks (12). Based on the prevailing literature, it is plausible that sustained overload of the smallest motor units of the muscle leads to homeostatic disturbances and eventually trapezius myalgia (13).

Physical exercise has been suggested as a treatment of musculoskeletal disorders (14–16). While some studies have found no effect of physical training on nonspecific pain in the neck area (17,18), others have demonstrated that pain can to some extent be reduced by strength training (15,16,19,20), endurance training (19,20), and muscle coordination training (20). According to a recent review there is limited evidence for the efficacy of physical exercise in the treatment of symptoms of the neck and/or shoulder due to a lack of targeted high-quality research (21). In particular, a lack of any clear difference in the response to different forms of exercise seems due to overlap between applied exercise modalities. Exercise of pain-

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ful muscles has been shown to result in an acute increase in the interstitial tissue concentrations of nociceptive substances (22), and strength training especially leads to marked muscular soreness in the days following unaccustomed training (23). A more acceptable form of exercise for subjects with pain may be general fitness training, which has been shown to induce transient elevations in pain threshold in nonexercised parts of the body in healthy subjects (24,25), and has resulted in less use of pain medication in persons with chronic back pain (26). Furthermore, it has been indicated that individuals with low back pain should refrain from local muscle training and instead focus on general physical activity (27). Therefore, it is suggested that muscle activity in one part of the body will potentially affect distant muscles as well (28,29). Supporting this, vascular adaptations in the forearm muscle beds have been found with a training regimen designed to condition the lower extremities (30), and improved endothelial vasodilatory capacity in conduit arteries of nonworking limbs has been observed in response to exercise with the other limbs (31). Therefore, it remains unexplained whether specific training of the painful muscle or more general fitness training without direct involvement of the painful muscle should be recommended in rehabilitation of chronic neck muscle pain. This can be difficult to investigate because most types of general training involve activation of the painful muscle to some extent. As a model, leg bicycling with relaxed shoulders can be used to investigate the effect of general fitness training on local neck muscle pain.

Based on this background, we conducted a randomized controlled trial to determine acute and prolonged changes in work-related neck muscle pain in response to 1) specific strength training locally for the affected muscle, 2) general fitness training performed as leg bicycling with relaxed shoulders, or 3) a reference intervention without physical activity. We hypothesized that both types of physical training would be superior to the reference intervention with regard to pain reduction.

SUBJECTS AND METHODS

Study design. We performed a randomized controlled trial in Copenhagen, Denmark. The subjects were recruited from 7 workplaces (2 banks, 2 post office workplaces, 2 different national administrative offices, and 1 industrial production unit) during the period from September 2005 until March 2006. The work tasks at these companies were monotonous and repetitive, e.g., assembly line work and office work. In particular, computer work was common in that 82% of the participants worked at a computer and 79% used a keyboard for more than three-quarters of the working time. The procedure of recruitment is outlined in Figure 1.

The first step included a reply to a screening questionnaire (sent out to 802 female workers, age 30–60 years) in which the following inclusion criteria had to be fulfilled (the percentages of positive replies to each question for those who accepted [$n = 306$] and declined [$n = 214$]

participation, respectively, are given in parentheses): 1) pain or discomfort for >30 days during the last year in the neck region but no more than 3 regions of pain or discomfort in order to exclude generalized musculoskeletal diseases (58% and 27%); 2) pain or discomfort rated at least as “quite a lot” on an ordinal 5-step scale of “a little,” “somewhat,” “quite a lot,” “much,” and “very much” (48% and 20%); 3) frequent pain or discomfort (at least once a week on an ordinal scale of “seldom,” “once a week,” “2–3 times per week,” and “almost all the time”; 78% and 47%); and 4) the intensity of pain or discomfort rated at least 2 on a scale from 0 to 9, where 0 is no pain and 9 is the worst imaginable pain (77% and 47%) (32–34). Screening questionnaire exclusion criteria were serious conditions such as previous trauma or injuries, life-threatening diseases, cardiovascular diseases, or arthritis in the neck and shoulder. Finally, subjects had to respond that they were interested in participating.

A total of 147 women fulfilled the inclusion criteria, and of these 53 were excluded due to the above exclusion criteria or due to unavailable time during the intervention period. In total, 94 participated in a clinical neck and upper limb examination. This examination was performed by a team of 2 physicians and 3 physiotherapists and was originally developed by Ohlsson et al (35) and later modified as described in detail previously (12). Briefly, the main criteria for a positive clinical diagnosis of trapezius myalgia were 1) pain in the neck area, 2) tightness of the trapezius muscle, and 3) palpable tenderness in the trapezius muscle. Subjects who based on this examination qualified for trapezius myalgia and did not show contraindications corresponding to the overall exclusion criteria listed above following detailed interview ($n = 48$) were invited to participate in the study.

The participants were allocated to 3 different intervention groups: specific strength training (SST), general fitness training performed as leg bicycling (GFT), and health counseling as a reference group (REF). The participants were randomized at the cluster level to 1 of the 3 groups in a balanced design accounting for similar age, body mass index, and screening questionnaire report on neck/shoulder trouble. Requesting a statistical power of 80% calculations showed that 14 participants should be included in each group to allow a 15% change with intervention to be significant at the 5% level for the variables and their SDs used in this study with paired analysis. Unfortunately, the time-wise successive balanced recruitment resulted in a somewhat smaller REF group, e.g., due to withdrawal of participants who initially stated they would volunteer for the study. In total, 42 women (mean \pm SD age 44 ± 8 years, mean \pm SD height 165 ± 6 cm, mean \pm SD weight 72 ± 15 kg) clinically diagnosed with trapezius myalgia completed the study. All subjects were informed about the purpose and content of the project and gave written informed consent to participate in the study, which conformed to the Declaration of Helsinki and was approved by the local ethical committee (KF 01-138/04). The study qualified for registration in the International Standard Randomized Controlled Trial Number register (ISRCTN 87055459).

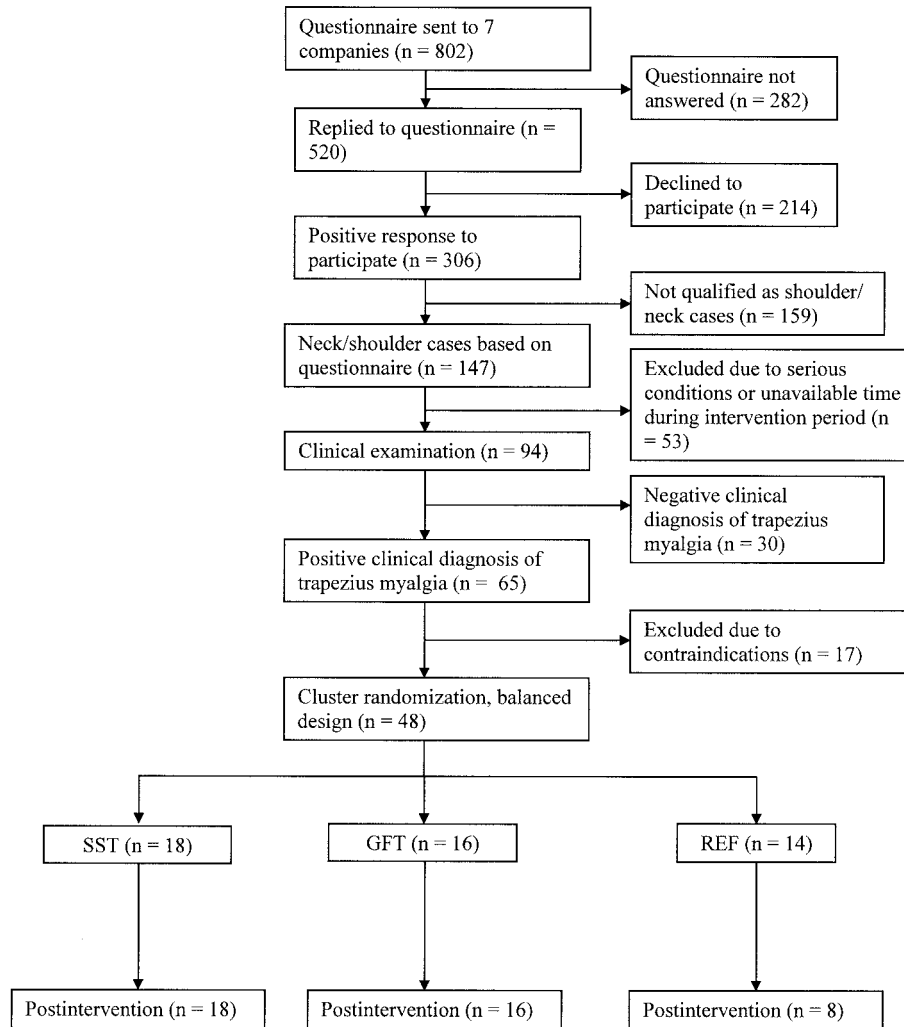


Figure 1. Flow chart of recruitment, clinical examination, and intervention. SST = specific strength training; GFT = general fitness training; REF = reference group.

Interventions. In all 3 intervention groups the total time allowed to spend on the project equaled 1 hour per week. In the SST and GFT groups, supervised training was performed at a high intensity for 20 minutes 3 times per week (on Mondays, Wednesdays, and Fridays) for 10 weeks, which has previously been shown to be a sufficient intervention period to achieve significant adaptations (16,20). The REF group was also allocated a total of 1 hour per week but met more irregularly for lectures giving information on activities promoting general health.

The SST group ($n = 18$) performed supervised high-intensity specific strength training locally for the neck and shoulder muscles with 5 different dumbbell exercises (1-arm row, shoulder abduction, shoulder elevation, reverse flies, and upright row). During the intervention period the training load was progressively increased according to the principle of periodization and progressive overload (23). Relative loadings were progressively increased from 12 repetitions maximum (RM; $\sim 70\%$ of maximal intensity) at the beginning of the training period to 8 RM ($\sim 80\%$ of maximal intensity) during the later phase. The strengthening exercises were performed in a conventional manner

using consecutive concentric and eccentric muscle contractions, i.e., raising and lowering the pair of dumbbells in a controlled manner without pause or breaks, and each set typically lasted 25–35 seconds. Three of the 5 different exercises with 3 sets per exercise were performed during each training session in an alternating manner, with shoulder elevation being the only exercise that was performed during each session.

The GFT group ($n = 16$) performed high-intensity general fitness training with the legs only on a Monark bicycle ergometer (Monark, Varberg, Sweden) for 20 minutes at relative workloads of 50–70% of maximal oxygen uptake (VO_{2max}). The subjects bicycled in an upright position without holding onto the handlebars. It was emphasized that the subjects in GFT should relax the shoulders during training. A relative workload of 50% of VO_{2max} was used during the initial training sessions and the intensity was progressively increased toward 70% during the following weeks and was maintained at that intensity throughout the remaining training period. The relative workload was estimated based on the known relationship between heart rate (HR) and oxygen uptake, i.e., relative workload =

(working HR – resting HR)/(maximum HR – resting HR), where resting HR was set at 70 beats per minute and maximum HR was estimated as 220 minus age. HR was recorded in each subject by a heart rate monitor (Polar Sport Tester, Polar, Kempele, Finland) during each training session to adjust the workload to meet the intended relative level.

The REF group ($n = 8$) received an equal amount of attention as the physical training intervention groups but was not offered any physical training. These women received health counseling on a group level and an individual level with regard to workplace ergonomics, diet, health, relaxation, and stress management for a total of up to 1 hour per week. Some lectures lasted up to 1 hour and therefore, to keep the total allocated time equal between intervention groups, these lectures could not be performed regularly 3 times per week.

Primary outcome measure. The intensity of pain in the trapezius muscle was rated subjectively on a 100-mm visual analog scale (VAS), where 0 mm indicated “no pain at all” and 100 mm indicated “worst possible pain” (36). Changes in pain were considered clinically significant when a statistically significant change of at least 10 mm occurred (37). Pain in the GFT and SST groups was recorded in a training log in each of the 30 training sessions. Five parameters were noted: 1) pain in general since the last training session, 2) pain at its worst since the last training session, 3) pain immediately before the present training session, 4) pain immediately after the present training session, and 5) pain 2 hours after the present training session. The first 2 parameters were used to evaluate the prolonged effect of training and the last 3, to assess the acute effect of training. The REF group completed a logbook on parameters 1 and 2 on Mondays, Wednesdays, and Fridays at noon.

The prolonged effect of the interventions was determined as the continuous change over time in 2 pain parameters: general and worst pain since the last training session. Furthermore, to assess the effect of detraining, general and worst pain in the preceding week was noted once a week for 10 successive weeks after the postintervention test in all 3 groups.

The acute effect of training on pain in the SST and GFT groups was determined as the difference between VAS pain immediately before and immediately after each training session, as well as the difference between VAS pain immediately before and 2 hours after each training session. To evaluate the acute effect separately during the first and second half of the training period, the statistical analyses were performed separately for training sessions 1–15 and 16–30, respectively.

Secondary outcome measures. Åstrand’s standardized method was used to estimate aerobic fitness (VO_{2max}) during a submaximal workload provided by a bicycle ergometer (Ergonomic 874E; Monark) (38). Testing of maximal voluntary isometric muscle strength was performed during shoulder elevation (prime mover: trapezius muscle) and

shoulder abduction (prime mover: deltoid muscles) according to a standardized procedure (39).

Statistical analysis. All statistical analyses were performed using the SAS statistical software for Windows (SAS Institute, Cary, NC). The change in VAS pain was evaluated with a variance component model with random subject effect corresponding to repeated-measures analysis of variance and the assumption of compound symmetry. Variables included in the model were group (GFT, SST, REF; class variable) and time (training sessions 1–30; continuous variable resulting in linear regression analyses), as well as group-by-time interaction. An alpha level of 0.05 was accepted as significant. All values are reported as the mean \pm SD.

RESULTS

Baseline. Prior to the intervention, the subjects in the 3 groups did not differ with regard to anthropometric measurements, level of pain (Table 1), muscle strength, and fitness level (Table 2).

Training and compliance. Thirty training sessions were planned during the 10-week intervention period. The actual mean \pm SD number of training sessions and pain registrations were 25 ± 4.8 , 26 ± 3.6 , and 27 ± 2.8 for GFT, SST, and REF, respectively. The training load in both GFT and SST increased linearly with time, and was doubled by the end of the 10 weeks of training (Figure 2C), which confirmed the high compliance documented in the training logbooks of the participants for the respective training programs.

Aerobic fitness and muscle strength. In response to the 10-week intervention, VO_{2max} was increased 21% in the GFT group, from 28 ± 6 ml $O_2 \cdot \text{minute}^{-1} \cdot \text{kg}^{-1}$ to 33 ± 7 ml $O_2 \cdot \text{minute}^{-1} \cdot \text{kg}^{-1}$ ($P < 0.001$), whereas no statistical change occurred in the other groups. Isometric muscle strength increased significantly in the SST group during shoulder elevation (right side: 30%, left side: 29%) and shoulder abduction (right side: 28%, left side: 29%) (Table 2).

Prolonged effect of training on pain. The time-by-group interaction was highly significant ($P < 0.0001$). Over the 10-week intervention period, the SST group alone decreased by 35 mm and 20 mm in worst pain and general pain, respectively, as measured by the VAS scale (Table 1, Figure 2). Of the 18 subjects in the SST group, 17 had a decrease in pain. In SST the mean \pm SD rate of decrease in pain was -1.03 ± 0.30 mm per session ($P < 0.0001$) and -0.58 ± 0.22 mm per session ($P < 0.0001$) for worst and general pain, respectively. In contrast, no significant change over time was observed in the GFT and REF groups. During the 10-week postintervention followup period, no change in pain occurred in any of the 3 groups, and the SST group remained at a level that was significantly lower than the GFT and REF groups ($P < 0.001$) (Table 1, Figure 2).

Table 1. Baseline characteristics and VAS score (100-mm scale) for pain in general and worst pain during the last 3 days at pre- and postintervention and 10 weeks after the intervention*

Characteristic	GFT	SST	REF
Age, years	45 ± 9	44 ± 9	42 ± 8
Weight, kg	74 ± 19	73 ± 12	68 ± 12
Height, cm	165 ± 5	165 ± 6	166 ± 8
BMI, kg/m ²	27 ± 7	27 ± 5	25 ± 3
VAS score (worst pain), mm			
Preintervention	50 ± 16	44 ± 25	43 ± 27
Postintervention	45 ± 13	10 ± 10†	35 ± 29
10 weeks postintervention	39 ± 15	19 ± 18†	38 ± 20
VAS score (general pain), mm			
Preintervention	35 ± 21	28 ± 15	31 ± 20
Postintervention	33 ± 12	8 ± 9†	30 ± 22
10 weeks postintervention	29 ± 15	16 ± 14†	30 ± 18

* Values are the mean ± SD. VAS = visual analog scale; GFT = general fitness training; SST = specific strength training; REF = reference group; BMI = body mass index.
† Significantly different from pretraining value ($P < 0.001$).

Acute effect of training on pain. In response to training, the GFT group had an acute decrease in VAS pain during both the first half (-5.3 ± 6.5 mm; $P < 0.01$) and the second half (-4.9 ± 5.5 mm; $P < 0.01$) of the 10-week training period (Figure 3). In contrast, the SST group showed an acute increase in pain during the first half of the training period (4.8 ± 8.9 mm; $P < 0.05$), but not during the second half. Two hours after the training sessions, the acute effect in both groups had leveled off, i.e., the level of pain was back to levels that were not significantly different from those immediately prior to the training session (Figure 3).

DISCUSSION

The present study demonstrated that high-intensity SST and GFT have statistically significant effects on chronic neck muscle pain in employed women. The GFT group showed a decrease of 5 mm in neck muscle pain only immediately after exercise, which is considered to be of minor clinical relevance. In contrast, the SST group demonstrated a marked decrease in pain (35 mm, ~79%) over a prolonged training period and with a lasting effect after cessation of the training. Thus specific strength training

locally of the neck and shoulder muscles is the most beneficial treatment in women with chronic neck muscle pain.

Over the 10-week intervention period in SST, pain decreased linearly: 20 mm (~71%) and 35 mm (~79%) from baseline for general and worst VAS pain, respectively (Figure 2, Table 1). Previous strength training studies of similar duration and comparable baseline VAS pain values found only modest pain reductions of 17–25% in women with nonspecific neck pain (15,16), 25–39% in women with trapezius myalgia (20), or no change in nonspecific neck pain compared with a control group (17). A study of 1 years' duration found a 69% decrease in nonspecific neck pain (19). The markedly positive and rapid response in the present study compared with previous studies is likely to be caused by several factors. First, the basic training variables were different between studies. Most studies, as in the present study, used training frequencies of 3–5 times per week with durations of 8–15 weeks (16,17,20). However, there are distinct differences in intensity, specificity, volume, and contraction mode. According to the American College of Sports Medicine guidelines, the most pronounced adaptations at the muscle cellular level are achieved in response to progressive and periodized dynamic strength training involving both concentric and ec-

Table 2. Fitness and maximal muscle strength before and after the 10-week intervention*

	VO _{2max} (ml O ₂ · minute ⁻¹ · kg ⁻¹)	Shoulder elevation (Nm)		Shoulder abduction (Nm)	
		Right	Left	Right	Left
GFT preintervention	28 ± 6	52 ± 18	55 ± 15	40 ± 10	41 ± 11
GFT postintervention	33 ± 7†	57 ± 21	55 ± 14	39 ± 15	41 ± 17
SST preintervention	31 ± 7	58 ± 21	56 ± 16	42 ± 15	43 ± 16
SST postintervention	33 ± 8	75 ± 19†	72 ± 20†	53 ± 16†	56 ± 16†
REF preintervention	33 ± 9	48 ± 22	44 ± 20	37 ± 8	37 ± 9
REF postintervention	35 ± 7	58 ± 18	49 ± 16	41 ± 7	42 ± 7

* Values are the mean ± SD. The SST group increased muscle strength, whereas the GFT group increased fitness (VO_{2max}). VO_{2max} = maximal oxygen uptake; see Table 1 for additional definitions.

† Significantly different from pretraining value ($P < 0.001$).

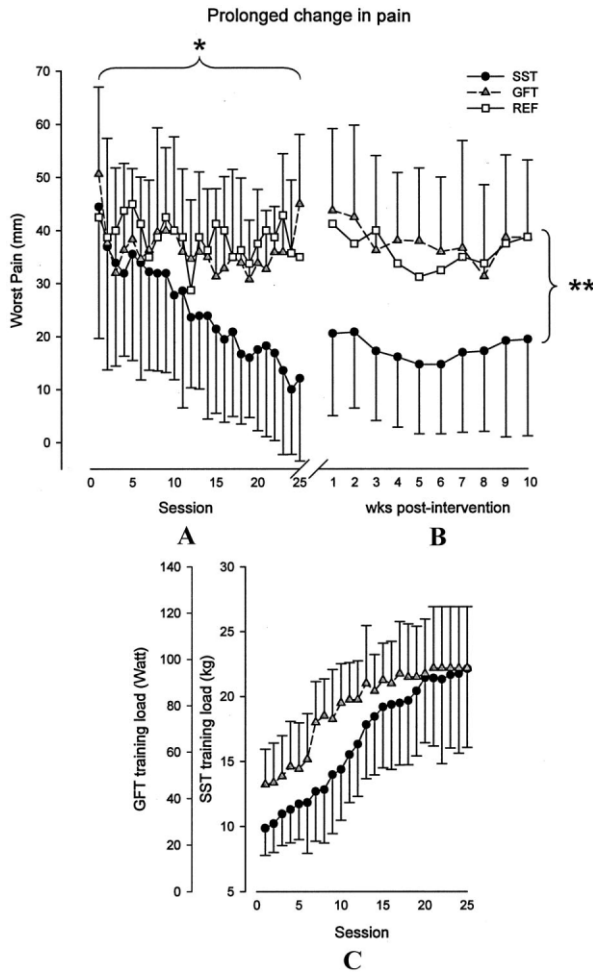


Figure 2. Prolonged effect of training. **A**, Trapezius muscle pain (worst) decreased in the specific strength training (SST) group during the 10-week intervention period, whereas no change over time occurred in the other 2 groups (general fitness training [GFT] and reference [REF]). **B**, During the 10-week postintervention period, pain was unchanged in all 3 groups and remained at a level that was statistically lower in SST compared with GFT and REF ($P < 0.001$). **C**, Training load in SST and GFT progressively increased throughout the training period to values that were approximately twice the initial level. * Significant time-by-group interaction ($P < 0.0001$); time effect: SST ($P < 0.0001$). ** Group effect: pain is less in SST than in the GFT and REF groups ($P < 0.001$).

centric contractions with a high intensity (8–12 RM for beginners) and a high volume (multiple sets) (23). In the present intervention, these variables were optimized by letting the dynamic strength training consist of both concentric and eccentric contractions with a high intensity (8–12 RM) and a high volume (9 sets per session) performed in a periodized and progressive manner (Figure 2C). In contrast, previous studies have used low intensity (15,17), high intensity but only concentric contractions (20), high-intensity isometric training (16,19), low total training volume (16), and nonperiodized training (15,16,19,20).

Another factor that may influence the outcome is the specificity of the diagnosis. All participants in the present study were clinically diagnosed with trapezius myalgia

and had to meet a number of self-reported neck symptom criteria. Whereas one study also included women specifically with trapezius myalgia (20), other studies included women with nonspecific neck pain (15,16,19). As in the present study, clinical examinations were performed in those previous studies and serious disorders such as arthritis, chronic headache, whiplash, and severe spinal disorder were excluded (16,17,19,20). Based on the inclusion and exclusion criteria in those studies, it is likely that a majority of the subjects with nonspecific neck pain had trapezius myalgia. In the present study, two-thirds (65 of 94) of the women with nonspecific neck pain according to questionnaire responses who participated in the clinical examination were diagnosed with trapezius myalgia (Figure 1). Therefore, it is likely that up to one-third of the subjects in previous studies did not have muscle afflictions that might respond positively to strength training, accounting for the relatively lower response level in those studies. Thus, a lower level of comorbidity may partly explain the higher response level in the present study.

Another factor that could affect the outcome is recruitment selection. The group of women who accepted participation in the intervention had more symptoms in the neck region regarding all 4 screening inclusion variables compared with those who declined, as presented in the Subjects and Methods section. One success criteria for high compliance is motivation, and positive results on the effect of training may increase motivation for subsequent studies. Of note is that the present study was not a cross-sectional population study intended to reveal to what extent it is possible to involve workers in physical activity programs at the workplace. The goal for the present study was to enroll a relatively homogeneous group of workers with unspecific soft tissue pain symptoms who could benefit from physical exercises, and to specify the criteria for

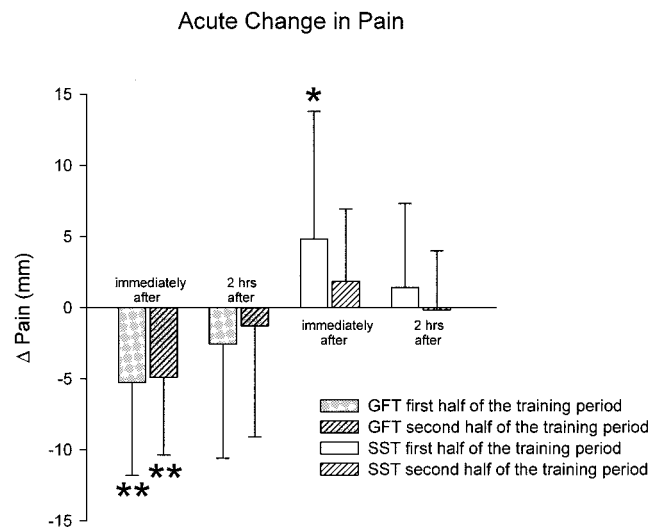


Figure 3. Acute effect of training. Pain in the trapezius muscle decreased immediately after bicycling in general fitness training (GFT) throughout the training period; however, the effect lasted <2 hours. In contrast, pain was increased immediately after specific strength training (SST) during the first half of the training period, but not during the second half. This acute adverse effect of SST lasted <2 hours. ** $P < 0.01$. * $P < 0.05$.

inclusion to provide subsequent recommendations regarding symptom patterns for workers who may benefit from the exercise programs developed for this study.

The present study demonstrated that in response to SST, the reduction in pain occurs gradually over time (Figure 2). It is well known that high-intensity strength training accelerates protein synthesis as well as degradation (40), which over a prolonged period may lead to turnover of painful and abnormal muscle tissue (41). Also, shoulder elevation strength of the trapezius muscle was increased 28% in the SST group (Table 2), which may lower the relative workload of the trapezius muscle during daily low-force work tasks. Pain of the trapezius muscle gradually decreased as the dynamic muscle strength increased (Figure 2). Thus, increased reserve capacity of trapezius muscle strength in response to strength training may also have contributed to pain reduction. In the GFT group, aerobic fitness increased 21% but no change in local pain occurred over a prolonged period. This finding indicates that local muscle training is necessary to significantly decrease pain. A transfer effect, as seen previously, of strength gains (42) and vascular adaptations in nontrained muscle groups (30) resulting from training one muscle group was not found regarding pain reduction.

GFT decreased pain acutely but the effect was of minor clinical relevance (i.e., <10 mm) and lasted <2 hours (Figure 3). However, even minor decreases in pain may be a motivating factor for persons with severe pain to overcome barriers to exercise, and increased fitness in response to GFT (Table 2) may increase overall health in the long term (43). Likely explanations for a statistically significant reduction of pain in response to GFT may be related to the release of β -endorphin (44), increase in core temperature (45), and increase in trapezius muscle oxygenation (46). In contrast, strength training caused acute increases in muscle pain at the beginning of the training period (Figure 3). Mechanical strain of the musculotendinous complex (47) and buildup of metabolites (22) in response to local muscle contractions may explain the transient amplification of pain. This adverse effect, which only occurred during the first half of the training period, may not be important because the increase was of minor clinical significance and was back to baseline levels after 2 hours (Figure 3), and general and worst pain were reduced from session to session during the entire intervention period (Figure 2). Qualified supervision of the training ensured that immediate action was taken to change exercises in order to avoid development of adverse effects.

A limitation of the present study is the initial dropout of participants in the REF group, which resulted in a smaller reference group ($n = 8$). However, considering that no change occurred in this group and that correspondingly no prolonged change in pain occurred in the GFT group ($n = 16$), the latter group may also be considered as a reference intervention to SST.

In conclusion, the marked reduction in pain of 35 mm (~79%) on the VAS scale in the SST group is of major clinical importance. This effect also lasted after cessation of the intervention. The GFT group showed acute statistically significant pain reduction, although this result was of minor clinical relevance (5 mm). Based on the present

results, supervised high-intensity (8–12 RM) dynamic strength training of the painful muscle 3 times a week for 20 minutes should be recommended in the treatment of trapezius myalgia.

AUTHOR CONTRIBUTIONS

Mr. Andersen had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Study design. Andersen, Sjøgaard, Sjøgaard.

Acquisition of data. Andersen, Sjøgaard, Kryger, Sjøgaard.

Analysis and interpretation of data. Andersen, Kjær, Sjøgaard, Hansen, Kryger, Sjøgaard.

Manuscript preparation. Andersen, Kjær, Sjøgaard, Hansen, Kryger, Sjøgaard.

Statistical analysis. Andersen.

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