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Effectiveness of small daily amounts of progressive resistance training for frequent neck/shoulder pain: Randomised controlled trial

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ABSTRACT

Regular physical exercise is a cornerstone in rehabilitation programs, but adherence to comprehensive exercise remains low. This study determined the effectiveness of small daily amounts of progressive resistance training for relieving neck/shoulder pain in healthy adults with frequent symptoms; 174 women and 24 men working at least 30 h per week and with frequent neck/shoulder pain were randomly assigned to resistance training with elastic tubing for 2 or 12 minutes per day 5 times per week, or weekly information on general health (control group). Primary outcomes were changes in intensity of neck/shoulder pain (scale 0 to 10), examiner-verified tenderness of the neck/shoulder muscles (total tenderness score of 0 to 32), and isometric muscle strength at 10 weeks. Compared with the control group, neck/shoulder pain and tenderness, respectively, decreased 1.4 points (95% confidence interval −2.0 to −0.7, $p < 0.0001$) and 4.2 points (95% confidence interval −5.7 to −2.7, $p < 0.0001$) in the 2-minute group and 1.9 points (95% confidence interval −2.5 to −1.2, $p < 0.0001$) and 4.4 points (95% confidence interval −5.9 to −2.9, $p < 0.0001$) in the 12-minute group. Compared with the control group, muscle strength increased 2.0 Nm (95% confidence interval 0.5 to 3.5 Nm, $p = 0.01$) in the 2-minute group and 1.7 Nm (95% confidence interval 0.2 to 3.3 Nm, $p = 0.02$) in the 12-minute group. In conclusion, as little as 2 minutes of daily progressive resistance training for 10 weeks results in clinically relevant reductions of pain and tenderness in healthy adults with frequent neck/shoulder symptoms.Trial registration: www.isrctn.org/ISRCTN60264809.

1. Introduction

Musculoskeletal disorders are common and costly. In the general population, the 1-year prevalence of neck/shoulder pain is 30% to 50% [11]. In particular, long hours of computer work can lead to development of neck/shoulder pain [9,13,14], and among computer workers the 1-year prevalence of neck/shoulder pain exceeds 50% [6]. Internet World Stats estimates that there are 1.8 billion internet users, and thus at least as many computer users, worldwide [20]. Tenderness and tightness of the neck/shoulder muscles is a common clinical finding among intensive computer users [15]. In the general population, chronic neck pain is reported in 7% to 22% of women and 5% to 16% of men [31]. The socioeconomic consequences of chronic disorders in the neck and shoulders in terms of disability, sick leave, and early retirement are considerable [16,21]. Because previous musculoskeletal pain is associated with a worse prognosis, early management of symptoms is critical [7,19]. Thus, initiatives to reduce the prevalence of neck/shoulder pain in healthy adults with frequent symptoms but who are not yet disabled or on sick leave are important.

Providing information on physical exercise, diet, smoking, and alcohol use is the most traditional way of improving public health. Although regular physical exercise accelerates recovery of many diseases and disorders [22], no standard treatment for neck/shoulder pain exists, and the most common advice is to stay active [29]. The American College of Sports Medicine recommends that adults perform resistance exercise for at least 2 to 3 days per week for proper musculoskeletal health [25]. However, regular exercise is challenging for many people, as indicated by a British health survey showing that among the general population only 37% of men and 24% of women fulfilled public recommendations of physical activity [1]. Among healthy as well as disabled adults, "lack of time" is often cited as a major reason for not adhering to physical exercise [27].

Systematic reviews report limited to moderate evidence for the effectiveness of physical exercise in relieving neck/shoulder pain [12,28]. Whereas one high-quality randomised controlled trial in

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patients with chronic neck pain has found no effect of dynamic resistance training compared with advice to continue ordinary physical activity [29], another has shown major benefits of a comprehensive multimodal program emphasising neck/shoulder resistance training [32]. Studies of lower methodological quality have mostly shown positive effects of neck/shoulder resistance training [5,10,24,30]. Therapists often recommend strengthening exercises combined with other physical therapies for relieving pain symptoms, but a major obstacle for many people is the length of comprehensive exercise programs. In healthy adults, regular performance of single sets of resistance exercise, which can be performed within few minutes at a time, leads to significant gains in muscle strength [25]. Thus determining the possible treatment effect of brief exercise programs for neck/shoulder pain is essential.

Our study investigated the effectiveness of small daily amounts of progressive resistance training for relieving neck/shoulder muscle pain in adults with frequent symptoms. We used the most traditional method of improving public health, providing health information, as the control.

2. Methods

2.1. Study design and flow of participants

We performed a randomised controlled trial in Copenhagen, Denmark. The local ethical committee of Copenhagen and Frederiksberg approved the study (HC2008103). The main outcome measures of this trial were changes in intensity of neck/shoulder pain (scale 0 to 10 points), examiner-verified palpable tenderness of the neck/shoulder muscles (total tenderness score of 0 to 32 points), and isometric muscle strength at 10 weeks. Fig. 1 shows the flow of participants through the study. Recruitment started in August 2009 and ended in September 2009, and follow-up of the last participant ended in December 2009.

We defined a set of criteria for locating healthy employees with frequent neck/shoulder muscle pain. In this study we defined "healthy employees" as those working full time and without known major disease or disability. A screening questionnaire went out to 1094 employees in 2 large white-collar organisations, and 653 replied. Exclusion criteria were a medical history of cardiovascular or cerebrovascular accident, fibromyalgia, rheumatoid arthritis, cervical disc prolapse, whiplash, other serious traumatic injury of the neck or shoulder, other serious chronic disease, pregnancy, working fewer than 30 h per week, or performing more than 2 h per week of vigorous physical exercise. We invited employees with self-reported neck/shoulder pain intensity of at least 2 on a scale of 0 to 10 during the previous 3 months, at least 30 days of pain during the previous year, and self-rated tenderness of the neck/shoulder muscles for a clinical examination (n = 305).

During the clinical examination, exclusion criteria for participation in the intervention were blood pressure above 160/100 (systolic/diastolic); a positive foramen compression test; subacromial impingement syndrome; or pain of the shoulder, elbow, or wrist during resisted shoulder abduction resulting in severe discomfort for the participant. Because a previous study had reported excellent test–retest reliability of palpable tenderness of the neck/shoulder muscles [15], we also tested for tenderness. Using a finger pressure of 2 kg, the clinical examiner determined tenderness by palpation of 8 neck/shoulder sites on the left and right side (upper trapezius, neck extensors, levator scapulae, infraspinatus, supraspinatus, medial deltoideus, muscle–tendon junction of the levator scapulae above angulus superior of scapulae, and the occipital border of the neck). The examiner used a score of 0 to 2, corresponding to no tenderness, some tenderness, or severe tenderness, respectively, for each site [15]. We then calculated a total tenderness score as the sum of these scores (ie, scale 0 to 32). Test–retest reliability from baseline to 10-week follow-up of the total tenderness score in the control group was excellent (intraclass correlation coefficient= 0.88).

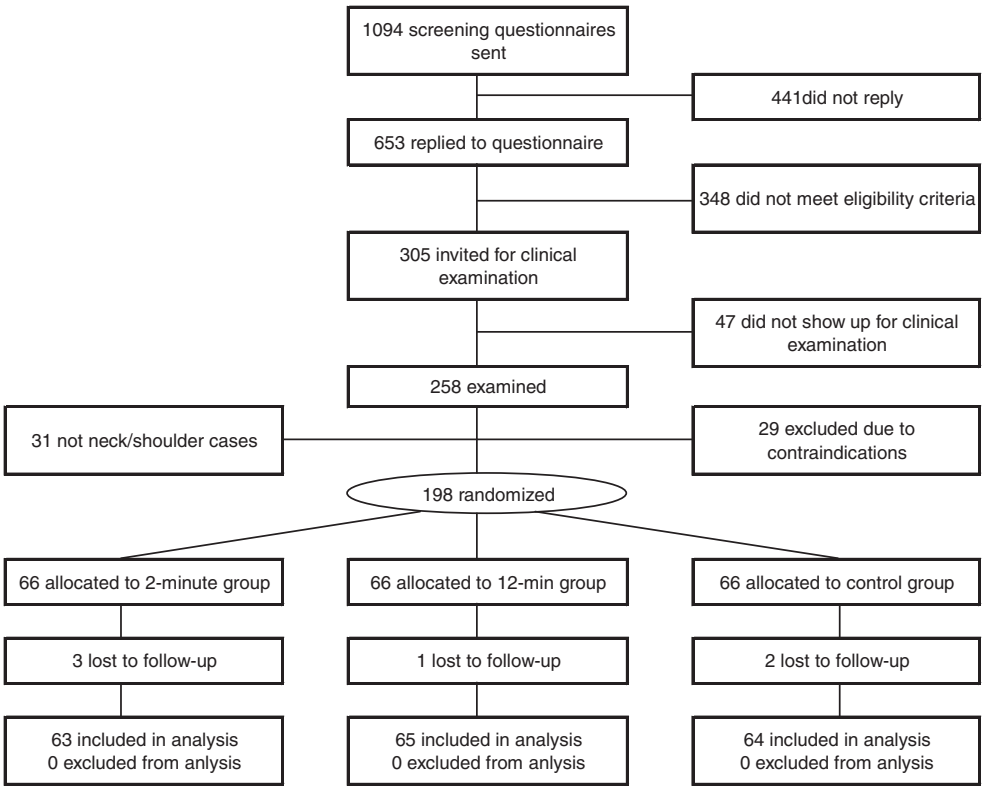

Fig. 1. Flow of participants through the study.

Using standardised instructions [3], the examiner also determined the participants' muscle strength as the maximal torque value of 5 attempts exerted during maximal voluntary shoulder abduction at a static 90° shoulder joint angle against a Bofors dynamometer (Bofors Elektronik, Karlskoga, Sweden). Test–retest reliability from baseline to 10-week follow-up of muscle strength in the control group was excellent (intraclass correlation coefficient = 0.95).

As a final step, we included those with an anamnestic history of frequent neck/shoulder muscle pain during the previous year and examiner-verified tenderness in at least 1 of the examined neck/shoulder muscles (n = 198) (Table 1). During examination, we excluded 31 participants because their pain history was atypical in relation to neck/shoulder symptoms among office workers, for example, a history of brief pain during the previous year due to sporting activities. All participants gave written informed consent in agreement with the Declaration of Helsinki.

Using a computer-generated random-numbers table, an independent statistician performed the random allocation of participants stratified for gender and workplace. The statistician had no information or influence on the eligibility of the participants. The statistician performed the randomisation procedure following the baseline examination of all participants, and then informed the participants via e-mail about group allocation, and stored the randomisation codes in a sealed opaque envelope until the study ended. Study personnel (investigators and clinical examiners) were blinded to treatment allocation, and participants were instructed not to reveal their particular intervention during follow-up examination. The statistician analysing the main data (author H.H.) remained blinded to group allocation until after he had run the prespecified statistical model. Before randomisation, we explained to the participants that none of the 3 interventions was known to be superior to the others. We initiated intervention activities in all 3 groups within 1 week after randomisation.

2.2. Interventions

A special ambition was to make the exercise program as simple and feasible as possible. The 2- and 12-minute groups performed progressive resistance training with elastic tubing (Thera-Band, Hygenic Corporation, Akron, OH, USA) 5 times per week, that is, for a total of 10 and 60 minutes per week, respectively. Elastic tubing in red, green, and blue was available, with the colours corresponding to resistances of 22 N, 29 N, and 40 N, respectively, at a stretched length of 150% above rest. To obtain higher resistances, participants combined the tubing in parallel. The participants performed shoulder abductions, also known as lateral raise, for effectively targeting several relevant neck/shoulder muscles [2,4]. The instruction was to stand at the middle of the elastic tubing while holding the handles on each side of the body, and then to raise both arms slightly in front of the body to 90° shoulder abduction and 30° shoulder horizontal flexion. The elbows were in a slightly flexed position (~5°) during the entire range of motion. Thirty minutes of initial training instruction and explanation of the progression scheme was obligatory for participants in both training groups. Physical therapists taught the participants to perform the training exercise in a controlled manner, that is, raising and lowering the arms in approximately 2 s. Although subsequent training was unsupervised, optional help with the program was available throughout the intervention period.

The 12-minute group performed 5 to 6 sets of 8 to 12 repetitions in a progressive manner, that is, for a total of 25 to 30 sets per week, which is the effective amount for treating trapezius myalgia in office workers [5]. During the first 2 weeks, they used moderate resistance (red tubing for women and green tubing for men). After 2 weeks they progressed to a higher level of resistance and followed instructions to increase resistance again when they could complete 6 sets of 12 repetitions. They were to begin new sets every other minute, completing their training sessions in 12 minutes.

The 2-minute group, although also performing shoulder abductions in a slowly controlled manner, performed only a single set to failure, that is, with as many consecutive repetitions as possible without pause between repetitions. During the initial 2 weeks, they used moderate resistance (red tubing for women and green tubing for men). Participants followed instructions to attempt to continuously break their own records in terms of repetitions. However, they were to terminate the set if they could perform repetitions for more than 2 minutes. After 2 weeks, participants

Table 1
Baseline characteristics of the three intervention groups. Values are group means (SD) or percentage of participants (%). The groups were not significantly different at baseline.

	2-minute	12-minute	Control
Demographics			
Age, year	44 (11)	42 (11)	43 (10)
Height, cm	171 (8)	170 (8)	169 (7)
Weight, kg	72 (14)	68 (15)	67 (11)
Body Mass Index, kg m^{-2}	25 (5)	24 (5)	23 (4)
Number of women/men	58/8	58/8	58/8
Clinical			
Days with pain previous year	176 (112)	209 (134)	180 (117)
Pain intensity previous 3 months, scale 0–10[a]	5.2 (1.9)	5.2 (2.1)	4.5 (1.9)
Pain intensity previous week, scale 0–10[b]	3.5 (1.7)	3.9 (2.2)	3.5 (1.7)
Total Tenderness Score, scale 0–32	13 (5)	13 (6)	11 (5)
Systolic BP, mmHg	127 (14)	124 (12)	126 (13)
Diastolic BP, mmHg	84 (10)	83 (9)	84 (9)
Isometric muscle strength (Nm)	45 (13)	44 (14)	44 (13)
Work-related			
Computer use, percentage of worktime	93 (14)	96 (10)	91 (16)
Weekly working hours	39 (5)	38 (5)	37 (3)
Duration of office work, years	11(9)	10(10)	13(11)
Higher education	92%	85%	89%
Other			
Smokers	10%	13%	5%
Living with a partner	79%	72%	75%

[a] From screening questionnaire.
[b] At baseline prior to start of the intervention.

progressed to a higher level of resistance, again receiving instructions to increase resistance when they could perform more than a specified number of repetitions according to the following scheme; 22, 20, 18, and 16 repetitions, respectively, at the 2nd (eg, green for women), 3rd, 4th , and 5th (eg, red + blue for women) levels of resistance.

During the 10-week intervention, the control group received weekly e-mailed information on various aspects of general health (physical exercise, advice to stay active in spite of pain, diet, smoking, alcohol use, stress management, workplace ergonomics, and indoor climate). We also provided internet links with additional relevant information.

2.3. Adherence

Participants in all 3 groups logged intervention activities once per week via an internet-based questionnaire. For the training groups, we defined adherence as the number of training sessions completed expressed as a percentage of the 50 possible sessions during the 10 weeks. For the control group, although not directly comparable to adherence of the training group, we defined adherence as the number of informational e-mails read expressed as a percentage of the 10 e-mails received during the 10 weeks.

2.4. Pain intensity

We asked participants to rate their pain intensity once per week via an internet-based questionnaire. A drawing from the Nordic Questionnaire defined the neck/shoulder area [17]. Participants rated their worst neck/shoulder pain during the previous week on a numerical rating scale from 0 to 10 with 21 points (ie, 0, 0.5, 1, ... 9.5, 10), where 0 is no pain and 10 is worst imaginable pain. The rating scale was horizontally oriented to represent a modified visual-analogue scale [23].

For reference, a change in pain intensity of 1 on a scale of 0 to 10 is considered the minimally important difference in patients with chronic musculoskeletal pain, and a change of 2 is considered to be moderately clinically meaningful [8]. In our population this corresponds to a pain reduction of approximately 25% and 50% from baseline, respectively.

2.5. Co-interventions

Participants in all 3 groups received the recommendation to continue their usual physical activities alongside the intervention and to refrain from using new therapies during the intervention period. The follow-up questionnaire showed that during the intervention 12%, 12%, and 13% of the participants in the 2-minutes, 12-minutes, and control groups, respectively, had received treatment by a doctor or physiotherapist for their neck/shoulder complaints, most commonly (in descending order) massage, chiropractic, and other physical therapies. The participants' level of leisure time physical activity, registered with a modified version of the Saltin & Grimby questionnaire [26], showed no significant change from baseline to follow-up. The follow-up questionnaire showed that none of the participants in the control group had performed neck/shoulder training with elastic tubing. However, 17%, 15%, and 17% of the participants in the 2-minute, 12-minute, and control groups, respectively, had performed other types of physical exercise that they believed exercised their neck/shoulder muscles, most commonly strength training, swimming, Pilates, yoga, gymnastics, and aerobics.

2.6. Sample size

Power calculations performed before the study showed that 48 participants in each group were necessary for testing the null hypothesis of equality of treatment at an alpha level of 5%, a statistical power of 95%, and a minimally relevant difference in pain intensity of 1 on a scale of 0 to 10. At an estimated dropout or loss to follow-up of 20%, the required number of participants in each group was 60.

2.7. Statistical analysis

We performed all analyses in accordance with the intention-to-treat principle [18]. For pain intensity, we used linear regression analysis to calculate the slope of the pain-time curve for each individual, and we estimated the change from baseline to follow-up as the slope $\times$ 10. For palpable tenderness and muscle strength, we calculated the change from baseline to follow-up. For the main variables, the change from baseline to follow-up followed a normal distribution. We determined between-group differences for the change over time by analysis of variance, using the Genmod procedure of SAS (SAS Institute, Inc., Cary, NC, USA).

Further, we report the percentage of participants showing improvement and worsening of symptoms. In this population we define much improvement as $\geqslant$50% decrease, some improvement as between $\geqslant$25% and <50% decrease, no change as between <25% decrease and <25% increase, some worsening as between $\geqslant$25% and <50% increase, and much worsening as $\geqslant$50% increase from baseline to follow-up.

We used the SAS statistical software for all analyses (version 9.1), and accepted an alpha level of 5% as statistically significant. We report baseline results as means (SD) and changes from baseline to follow-up as means (95% confidence intervals) unless otherwise stated.

3. Results

Table 1 shows that at baseline the participants in the 3 groups were matched for demographic and clinical characteristics. Throughout the intervention period, participants in the training groups reported the following adverse events: worsening of neck muscle tension during and/or in the days after training (2-minute n = 1, 12-minute n = 4), shoulder joint pain during training (2-minute n = 1, 12-minute n = 4), pain in the upper arm during training (2-minute n = 1, 12-minute n = 1), pain of the forearm/wrist during training (12-minute n = 2), worsening of headache after training (2-minute n = 1, 12-minute n = 1). No long-lasting or major complications resulted from the training program. The control group did not report any adverse events.

Sixteen participants did not complete the intervention (6 in the 2-minute group, 9 in the 12-minute group, and 1 in the control group). In the training groups, 4 participants dropped out due to one of the adverse events previously mentioned, 2 due to other illnesses unrelated to the training program, 2 due to lack of time, and 8 with no reason given. In the control group, 1 participant dropped out with no reason given. In total, 14 of the 16 participants who did not complete the intervention volunteered to reply to the follow-up questionnaire, and 11 volunteered to participate in the follow-up clinical examination. Thus only 6 of the 198 participants were lost to follow-up (Fig. 1).

In the control group, adherence to the informational e-mails was 90%. The 2- and 12-minute groups performed on average 3.2 and 3.3 of the 5 intended training sessions per week, respectively, corresponding to a training adherence of 65% and 66%. The resistance of the elastic tubing used during training increased by a factor of about 2 during the intervention period, and it increased from a median of red tubing during the initial week to a median of blue tubing during the final week in both the 2- and 12-minute groups.

Fig. 2 shows the weekly change in pain intensity throughout the intervention. Analysis of variance showed a strong group-by-time effect for neck/shoulder pain intensity ($p < 0.0001$). Compared with the control group, pain intensity decreased in both training groups (Table 2). This change was not significantly different between the 2 training groups ($p = 0.12$).

Fig. 3 shows the change in examiner-verified tenderness from baseline to follow-up. Analysis of variance showed a strong group-by-time effect for the total tenderness score ($p < 0.0001$). Compared with the control group, tenderness decreased in both training groups (Table 2). This decrease was not significantly different between the 2 training groups ($p = 0.89$).

Analysis of variance showed a statistically significant group-by-time effect for muscle strength ($p = 0.02$). Compared with the control group, muscle strength increased significantly in the training groups (Table 2). This change was not significantly different between the 2 training groups ($p = 0.74$).

Table 3 shows that approximately half of the participants in the training groups showed much improvement of symptoms from baseline to follow-up, and only a few showed worsening of symptoms.

4. Discussion

Our study showed clinically relevant reductions of pain and tenderness and increased muscle strength in adults with frequent neck/shoulder symptoms in response to small daily amounts of progressive resistance training. Approximately half of the participants of the training groups showed much improvement of symptoms. These findings are relevant for millions of people with pain worldwide, individuals unwilling or unable to perform hours of exhausting exercise.

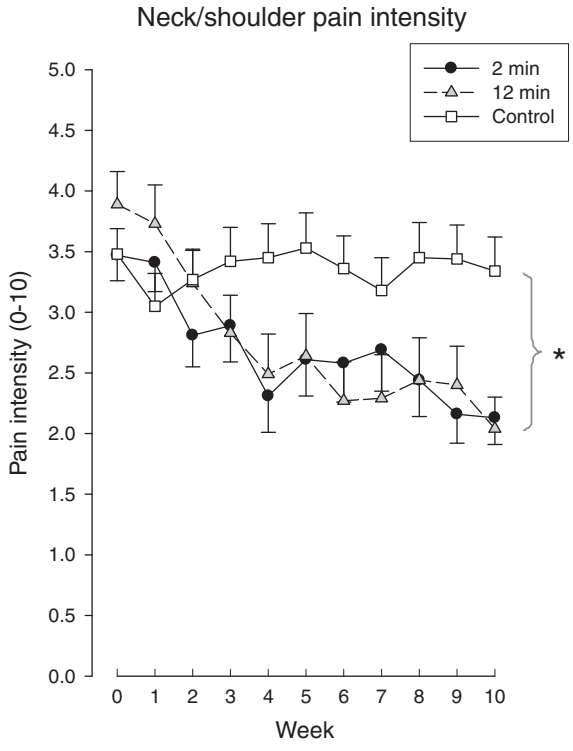

Fig. 2. Timewise change in intensity of neck/shoulder pain (scale 0 to 10) in the 2-minute, 12-minute, and control groups. A priori hypothesis testing of main effects showed a group-by-time effect ($p < 0.0001$), and post hoc tests showed significantly greater reduction of pain in the 2-minute and 12-minute groups compared with the control group ($*p < 0.0001$). Values are means (SE).

There are both strengths and limitations in our study. To protect against bias, we used concealed random allocation of participants and blinding of clinical examiners. Because blinding of participants in training studies is not possible, we cannot exclude the influence of placebo effects. However, the effect-size of changes in our study exceeds those previously reported in response to placebo [11]. Thus, the magnitude and direction of both subjective and clinical findings strengthens the validity of our results. Further, we explained to the participants prior to randomisation that none of the 3 interventions was known to be superior to the others. We obtained follow-up measurements from 97% of the participants, and we included dropouts in the intention-to-treat analysis, thus minimising bias from nonresponders. The amount of co-intervention was low and acceptable, and adherence was high in all 3 groups, thereby allowing us to investigate the actual effect of the intended interventions. The inclusion and exclusion criteria of our trial limit the generalisability of our results to healthy adults with frequent pain and tenderness of the neck and shoulder, that is, typical symptoms among intensive computer users. Because the participants worked at least 30 h per week, the results cannot be generalized to patients with severe work disability or on long-term sick leave. From a public health perspective, a limitation of randomised controlled trials focusing on physical exercise is the dependence on volunteers, because they may be more motivated to exercise than the general population. However, the high response rate to the screening questionnaire and the fact that three-fourths of those with self-reported symptoms were eligible for the study make the external validity of our findings high.

Few high-quality randomised controlled trials investigating the effectiveness of resistance training for relieving neck/shoulder pain exist [29,32]. In patients with chronic neck pain, Ylinen et al. [32] reported major treatment effects of a 1-year multimodal program emphasising neck/shoulder resistance training. Although the treatment effect was larger than that in our study, the need for initial institutional rehabilitation and the comprehensive nature of their protocol makes the applicability in large populations of healthy adults with frequent symptoms less feasible. In patients with chronic neck pain, Viljanen et al. [29] found no additional treatment effect of dynamic resistance training compared with advice to stay active. However, training adherence in that study was low, an average training frequency of once per week. Thus determining the actual effect of the intended intervention is difficult. By contrast, in our study adherence was high, with an average training frequency of more than 3 times per week for both training groups. Lack of time is frequently cited as a major reason for not adhering to exercise [27]. Because adherence was equally high in both training groups of our study, up to 12 minutes of daily exercise may not be a barrier for most people.

The weekly amount of resistance training in the 12-minute group, that is, 25 to 30 sets for a total of 1 h per week, is quantitatively comparable to the effective amount of resistance training for treating trapezius myalgia in office workers [5]. However, as little as 2 minutes of daily progressive resistance training performed as a single set of exercise to failure reduced pain and tenderness. Further, the 2 training groups displayed equivalent gains in muscle strength (approximately 5% to 6%). Although experts in strength training generally consider multiple-set systems superior for building muscular strength, other research reports positive physiological adaptations in untrained healthy adults performing single sets of resistance training [25]. Our study is the first to apply the single-set principle of progressive resistance training to an adult population with frequent pain. Previous neck/shoulder studies reported effectiveness of training sessions lasting 20 to 60 minutes [5,24,30,32]. However, we found no discernible difference in the treatment effects of the 2- and 12-minute program. Thus in relation to rehabilitation of musculoskeletal pain, the primary stimulus may occur during the first few minutes of exercise.

Table 2
Changes in neck/shoulder pain intensity, examiner-verified palpable tenderness, and muscle strength at 10-week follow-up (intention-to-treat analysis).

Outcome measure	Difference from baseline to follow-up			Between-group difference from baseline to follow-up					
	Control	2-minute	12-minute	2-minute vs control	*p* Value	12-minute vs control	*p* Value	2- vs 12-minute	*p* Value
Neck/shoulder pain intensity (0–10)	0.1 (−0.3 to 0.5)	−1.3 (−1.9 to −0.7)	−1.8 (−2.4 to −1.2)	−1.4 (−2.0 to −0.7)	<0.0001	−1.9 (−2.5 to −1.2)	<0.0001	0.5 (−0.3 to 1.3)	0.12
Total tenderness score (0–32)	−1.4 (−2.4 to −0.3)	−5.6 (−6.7 to −4.5)	−5.7 (−6.8 to −4.7)	−4.2 (−5.7 to −2.7)	<0.0001	−4.4 (−5.9 to −2.9)	<0.0001	0.1 (−1.4 to 1.6)	0.87
Muscle strength (Nm)	0.5 (−0.5 to 1.5)	2.5 (1.4 to 3.6)	2.3 (1.1 to 3.3)	2.0 (0.5 to 3.5)	0.008	1.7 (0.2 to 3.3)	0.02	0.3 (−1.3 to 1.8)	0.74

Differences for each group separately are shown on the left, and contrasts between the groups on the right. Values are means (95% confidence interval).

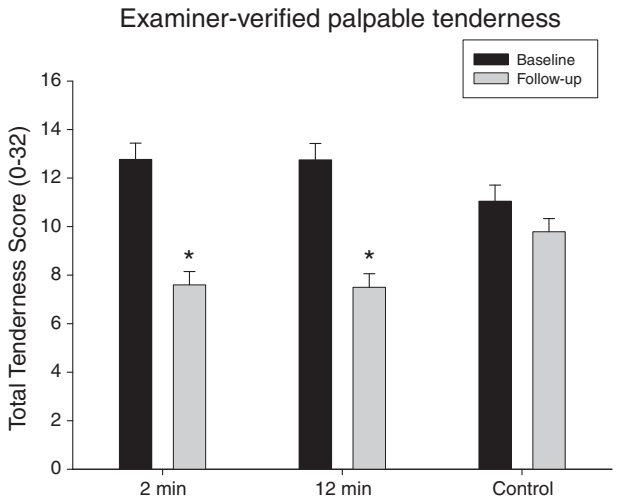

Fig. 3. Total tenderness score (scale 0 to 32) at baseline and at 10-week follow-up, calculated as the sum of examiner-verified palpable tenderness in 8 selected neck/shoulder sites of the left and right side in the 2-minute, 12-minute, and control groups. A priori hypothesis testing of main effects showed a group-by-time effect ($p < 0.0001$), and post hoc tests showed significantly greater reduction of pain in the 2- and 12-minute groups compared with the control group ($*p < 0.0001$). Values are mean (SE).

Table 3
Percentage of participants showing improvement, no change, and worsening from baseline to 10-week follow-up for perceived neck/shoulder pain intensity ($p < 0.0001$, Fisher exact test) and examiner-verified tenderness ($p < 0.0001$, Fisher exact test).

	Neck/shoulder pain intensity (%)			Total tenderness score (%)		
	2-minute	12-minute	Control	2-minute	12-minute	Control
Much improvement	40	49	13	44	50	5
Some improvement	27	16	17	18	15	12
No change	24	29	30	23	22	66
Some worsening	3	6	14	0	0	6
Much worsening	6	0	27	3	3	5

Cut-points for no change, much change, and some change were <25%, ⩾25% to <50%, and ⩾50%, respectively.

Adverse events were transient and were usually reported in relation to incorrect technique or overexertion. For safety reasons we avoided maximal loadings of a few repetitions and instead focused on loadings that the participants could properly perform for several repetitions. Whereas only 1 introductory session of 30 minutes was obligatory for the participants, previous studies used more prolonged supervision by training instructors or physiotherapists [10,30,32]. However, comprehensive supervision may not in practice be an available resource for most people. The globally increasing use of computers during work and leisure makes recommendations of simple, brief resistance training sessions for reducing neck/shoulder pain very important.

5. Conclusion

As little as 2 minutes of daily progressive resistance training for 10 weeks results in clinically relevant reductions of pain and tenderness and increased muscle strength in adults with frequent neck/shoulder symptoms.

Conflicts of interest statement

All authors declare that there are no conflicts of interest.

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