



# Effects of a workplace physical exercise intervention on the intensity of headache and neck and shoulder symptoms and upper extremity muscular strength of office workers: A cluster randomized controlled cross-over trial

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## Abstract

The purpose of the study was to examine the effects of a workplace physical exercise intervention on the perceived intensity of headache and the intensity of symptoms in the neck and shoulders, as well as on the extension and flexion strength of the upper extremities. The study was a cluster randomized controlled trial. The cross-over design consisted of physical exercise intervention (15 weeks) and no-intervention (15 weeks). The subjects ( $n=53$ ) were office workers (mean age 46.6 (SD 8.4)) who reported headache ( $n=41$ ) symptoms in the neck ( $n=37$ ) or shoulders ( $n=41$ ), which had restricted their daily activities during the last 12 months. Pain symptoms were measured using the Borg CR10 scale and muscular strength with a 5RM test. Statistical analyses were based on linear mixed models. Physical exercise intervention resulted in a slight, but statistically significant, decrease in the intensity of headache and neck symptoms, as well as an increase in the extension strength of the upper extremities. The mean decrease in headache during the 5-week period was 0.64 CR10 (95% CI 0.28–1.00) ( $P=0.001$ ) or 49% (95% CI 22–77), and 0.42 CR10 (95% CI 0.11–0.72) ( $P=0.002$ ) or 49% (95% CI 13–85) in the intensity of neck symptoms. The mean increase in the extension strength of the upper extremities was 1.3 kg (95% CI 0.5–2.1) ( $P=0.001$ ) or 4% (95% CI 1–6). The intervention had no effect on the intensity of shoulder symptoms or the flexion strength of the upper extremities. Specific exercise may be clinically important to alleviate headache and neck symptoms.

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## 1. Introduction

Pain symptoms are a major work-related health problem in many countries, even in sedentary occupations. The most common complaints have focused on neck, shoulders, and low back pains, and headache (Levoska, 1993; Linton

and Kamwendo, 1989; Seistamo and Klockars, 1997; Sjögren-Rönkä et al., 2001, 2002; Tola et al., 1988).

Therapeutic exercise has decreased the intensity of pain in cases of sub-acute or chronic low back pain (Campello et al., 1996; Mälkiä and Ljunggren, 1996; Mannion et al., 1999; Rodriguez et al., 1992; Torstensen et al., 1998; van Tulder et al., 1997b). Therapeutic exercise can also decrease the intensity of pain in the neck area (Kjellman et al., 1999; Konijnenberg et al., 2001; Ylinen et al., 2003), but so far, there have not been enough reliable studies to allow comparisons between different physical exercise interventions

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and training doses (Kjellman et al., 1999; Konijenberg et al., 2001; Randsløv et al., 1998; Rodriguez et al., 1992).

In the workplace, only a few randomized controlled studies have evaluated the effects of physical exercise interventions in relieving musculoskeletal symptoms and disorders (Linton and van Tulder, 2001; Maher, 2000; Poper et al., 2003). Only two of the studies (Gronningsäter et al., 1992; Takala et al., 1994) have focused on neck pain in physically light work. The results of the studies indicate that physical exercise can relieve musculoskeletal symptoms in the neck area (Gronningsäter et al., 1992; Linton and van Tulder, 2001; Poper et al., 2003; Takala et al., 1994).

In most previous studies, occupational physical workload, training dose and their interactions with musculoskeletal pain symptoms have not been analyzed carefully. Also, the contents of the physical exercise interventions have not been specified. When evaluating the results of these studies, it is difficult to determine whether the pain symptoms decreased due to training dose, guidance and education, and the interactions between these (Campello et al., 1996; Shephard, 1996) or whether the decrease was due to increased physical activity outside the controlled physical exercise intervention (Blue and Conrad, 1995; Howley, 2001; Liddle et al., 2004; Mälkiä and Ljunggren, 1996). Further, an important issue in studies of exercise and pain symptoms is the measurement of the physiological changes associated with training (Kuukkanen and Mälkiä, 1996; Viljanen et al., 2003; Ylinen et al., 2003).

To achieve a better understanding of the role of physical exercise in relieving pain symptoms, additional randomized, controlled physical exercise studies, especially in the workplace, are required. The purpose of this study was to examine the effects of a workplace physical exercise intervention, which consisted of light resistance training and guidance, on the perceived intensity of headache (i), the intensity of neck (ii) and shoulders symptoms (iii), as well as the muscular strength of the upper extremities (iv). Randomization was performed at the department level to prevent contamination between the physical exercise intervention and no-intervention groups, as well as to implement the study in an undivided and natural working community.

## 2. Methods and subjects

### 2.1. Study design and randomization

In this study, the criterion for inclusion at the cluster level was physically light work (average intensity about 1.5 MET, metabolic equivalent) performed by the workers of various departments in the City of Kuopio's Central Administration. The eligible source departments consisted of four departments and the source population consisted of 124 office workers. Four departments and 90 volunteered workers (73%) took part in the physical exercise intervention. The researcher randomized the four

departments into two treatment sequence groups. There were two departments in both groups and all the workers within a particular department received the same treatment sequence. The physical exercise intervention was performed using a cluster randomized (Campbell et al., 2004) cross-over design (Fig. 1).

The baseline measurements were performed before the first intervention period in September 1999. After the baseline measurements, the 'blind' measurers allocated the workers into the two treatment sequence groups, Treatment Groups 1 and 2, using cluster randomization. In the first period (autumn), Treatment Group 1 took part in the intervention while Treatment Group 2 did not. In the second period (spring), the roles were reversed so that now Treatment Group 2 took part in the intervention while Treatment Group 1 did not. The cross-over design was conducted without any washout time between the two treatments periods. Therefore, the second period commenced immediately after the first period in January. Both periods lasted for 15 weeks. The sequence was concealed until the interventions were assigned.

#### 2.1.1. Physical exercise intervention

The physical exercise intervention (=intervention) consisted of progressive light resistance training and guidance. As a part of their paid work, the participants were able to conduct their training in the departments' own training facilities' when they felt the need to counterbalance their sedentary work or to obtain relief from monotonous and fixed working positions. The time at which training could be performed during the working day was not determined. During the first 5-week period, the non-supervised resistance training was to be performed once each working day (five times a week). During the second and third 5-week periods, the resistance training was to be performed 1–2 times each working day (a total of about 7–8 times a week). At the department level, a physiotherapist provided training instructions and general guidance on postural and movement control in three group sessions.

#### 2.1.2. Light resistance training

The light resistance training consisted of six dynamic symmetrical movements: upper extremity extension, upper extremity flexion, trunk rotation to the right, trunk rotation to the left, knee extension and knee flexion. The training movements were carried out 20 times with a 30 s pause between the training movements. There was no defined sequence between the training movements, except that the physiotherapist recommended that, in regards to the upper extremity movements, the flexion movements should be performed after the extension movements. The training resistances of 30% of one repetition maximum (1RM) (McDonagh and Daves, 1984) for each movement were estimated at 5-week intervals for each individual with a sub-maximal 5RM test performed using air resistance equipment (HUR Ltd, Finland). The training load for the right and left trunk rotation movements was determined from the upper extremity flexion movement result. The average movement performance time for a single training movement was 1.8 s per repetition in one set (Sjögren and Mälkiä, 2003).

#### 2.1.3. Guidance

At the department level, a physiotherapist provided training instructions and general guidance on postural and movement control in three group sessions (3 × 20 min) at 5-week intervals. The subjects learned to use the Borg Rating of Perceived Exertion (RPE 6–20) and pain (CR10) scales (Borg, 1998, ACSM 2000)

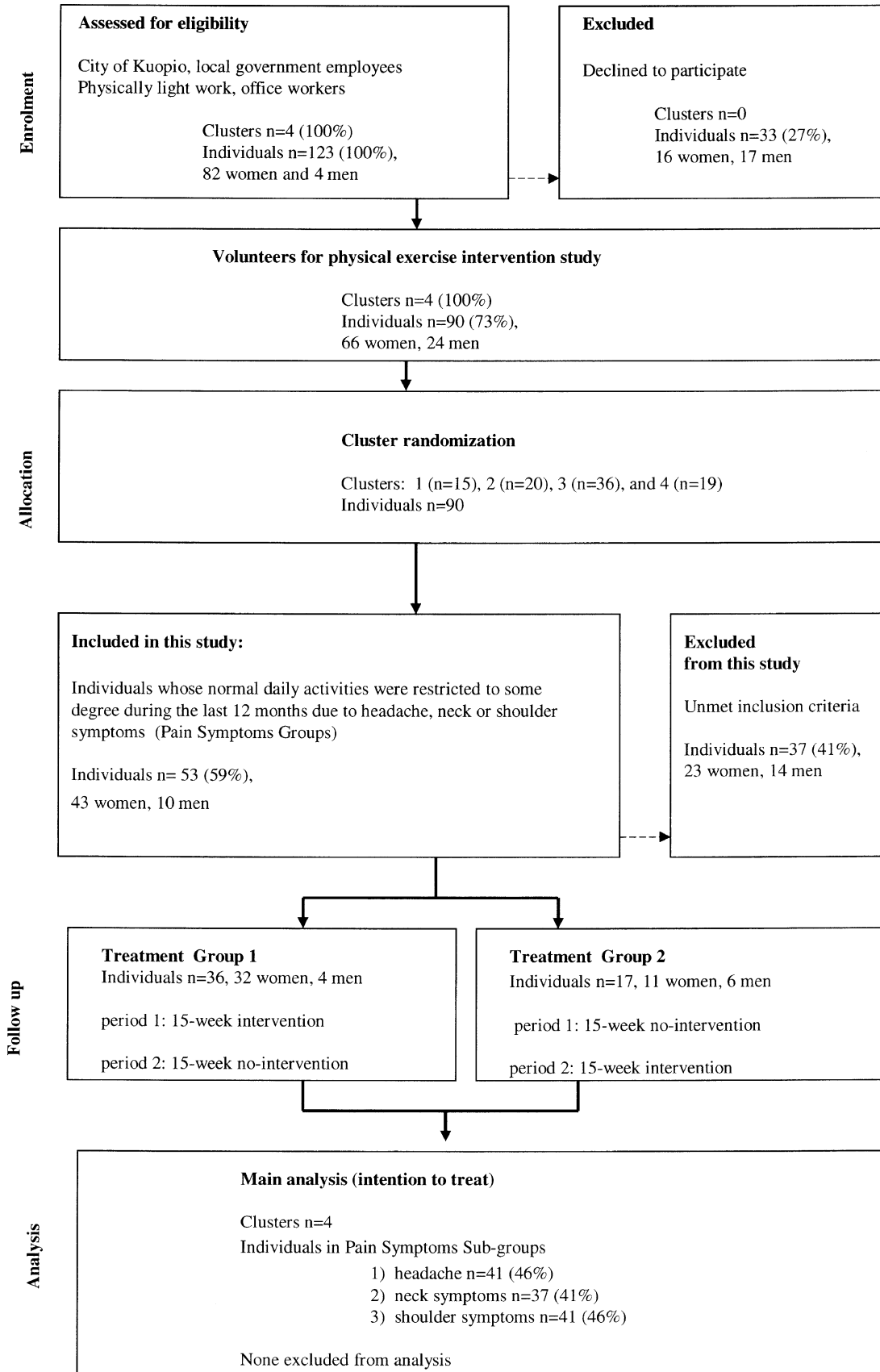


Fig. 1. Study subjects, design and randomization according to time flow.

to control their training. The workers were instructed that the perceived exertion should be light and pain levels on the CR10 scale should not temporarily increase by more than one unit from the starting level during an active training session. Moreover, neck and low back position, dynamic muscle contraction, as well as sufficient ranges of motion were specifically emphasized.

#### 2.1.4. No-physical exercise intervention

During the 15-week no-physical exercise intervention (= no-intervention) period, no light resistance training was performed nor was any guidance provided. The participants simply took part in the measurements.

#### 2.1.5. Avoiding physical and psychosocial co-interventions

Excluding the light resistance training, the participants were asked to keep the level of intensity and amount of their physical activity unchanged during the periods of intervention and no-intervention. The occupational health service personnel were instructed to not initiate any new activities in the field of occupational health and safety during the study.

## 2.2. Subjects

In this study, the main aim was to investigate changes in the degree of intensity in the pain symptoms of symptomatic office workers within the four departments. Subjects with symptoms were selected after physical exercise intervention from larger cluster randomized physical exercise study population, which also included asymptomatic office workers ( $n=90$ ) (66 women, 24 men, mean age 45.7 (SD 8.5) years). The clusters as a whole ( $n=4$ ) took part in the physical exercise intervention. At the individual level, the criteria for inclusion in this study were headache or pain or discomfort (=symptoms) in the neck or shoulders, which to some degree had restricted participation in daily activities during the 12-month period preceding the intervention (questionnaires reviewed in Andersson et al., 1987, and Kuorinka et al., 1987). This kind of allocation of the subjects into this study, in practice, resulted in a blinded study design. Of the 90 volunteers, 53 met one or more of the inclusion criteria. These 53 subjects (43 women, 10 men, mean age 46.6 (8.4) years) were labeled the Pain Symptoms Group and were categorized into three partially overlapping Pain Symptoms Sub-groups: the Headache Symptoms Group ( $n=41$ ; 33 women, 8 men), the Neck Symptoms Group ( $n=37$ ; 30 women, 7 men), and the Shoulder Symptoms Group ( $n=41$ ; 34 women, 7 men). At the baseline, there were no statistically significant differences in the intensity of pain symptoms at the individual level between genders or at the cluster level between departments. The individual level baseline information of the Pain Symptoms Group, and the intensity of the pain symptoms of the Pain Symptoms Sub-groups are presented in Table 1. At the individual level, the criterion for exclusion from this study was no restriction in daily activities during the last 12 months due to headache, neck or shoulder symptoms. Thirty-seven of the 90 volunteers, who did not meet any of the inclusion criteria, formed the Symptom-Free Group.

The main analysis, which was on the effects of a workplace physical exercise intervention on the intensity of pain symptoms, was performed separately for each of these three Pain Symptoms Sub-groups. At the department level there was no loss to follow-up,

Table 1

The individual level baseline information of the Pain Symptoms Group, and the intensity of the pain symptoms of the Pain Symptoms Sub-groups

	Mean (SD)			P
	All	Women	Men	
<i>1. Pain Symptoms Group (n=53, 43 women, 10 men)</i>				
Age, years	46.6 (8.4)	46.5 (8.7)	47.1 (7.2)	0.831
High (cm)	167.3 (8.3)	164.9 (6.2)	177.6 (7.6)	0.000
Weight (kg)	72.3 (15.4)	68.9 (13.0)	86.9 (16.9)	0.000
Upper extremity muscular strength, 1RM				
Flexion (kg)	50.2 (13.5)	44.3 (6.0)	73.4 (8.3)	0.000
Extension (kg)	38.0 (15.3)	31.6 (6.5)	62.6 (14.8)	0.000
<i>2. Pain symptoms sub-groups</i>				
Headache Symptoms Group ( $n=41$ , 33 women, 8 men)				
Intensity of headache <sup>a</sup>	2.3 (2.5)	2.3 (2.4)	2.1 (2.9)	0.859
Neck symptoms group ( $n=37$ , 30 women, 7 men)				
Intensity of neck symptoms <sup>a</sup>	2.4 (2.2)	2.2 (2.3)	3.1 (1.7)	0.308
Shoulder symptoms group ( $n=41$ , 34 women, 7 men)				
Intensity of shoulder symptoms <sup>a</sup>	2.7 (2.6)	2.8 (2.6)	2.3 (2.9)	0.494

<sup>a</sup> Borg CR10 scale:0–10.

and at the individual level two subjects were lost to follow-up. The reasons were poor state of health (1) and low motivation to the physical exercise intervention (1). The lost to follow-up results have been analyzed according to the intention-to-treat principle (Fig. 1). However, as the Symptom-Free counterparts participated in the measurements and physical exercise, some additional analyses involving them was performed.

## 2.3. Measurements

### 2.3.1. Intensity of pain symptoms

The intensity of headache and the intensity of symptoms in the neck and shoulders experienced during the previous 7 days were measured using the Borg CR10 scale at 5-week intervals. The scale describes the subjective level of the symptoms. The scale varies from 'nothing at all' (0) to 'extremely strong' (10) symptoms. 'Extremely weak' corresponds to 0.5 on the scale and is the threshold of what is possible to perceive. The reliability and validity of the Borg CR10 scale are good (Borg, 1998) and it has been recommended for use in exercise studies (ACSM, 2000).

### 2.3.2. Upper extremity muscular strength

The one repetition maximum (1RM) for the upper extremities was estimated with sub-maximal 5RM test (McDonagh and Daves, 1984) using air resistance equipment (HUR Ltd, Finland); the standardized test movements were upper extremity extension and flexion. The subjects performed five repetition sets with loads of 10, 20, 30 kg, etc. until they were unable to perform the defined sets properly. Pain was not allowed to increase during testing by more than five units on the Borg CR10 scale (Borg, 1998). The rest period between the 5RM test sets was 1 min, and then 3 min between the different test movement stations. In our reliability study ( $n=14$ –16), the consistency of the intra- and inter-observer

measurements (ICC) at 2 days intervals, according to the scaling by Baumgartner (1989), was high (ICC 0.95–0.98).

### 2.3.3. Physical activity

During the intervention period, each subject maintained a weekly diary to record training sessions, including the time in minutes spent performing light resistance training during each session. Other physical activity performed outside the intervention was controlled by a structured interview at 5-week intervals. Physical activity at work was assessed with a seven-point scale, which was accompanied by illustrations and descriptions of the various types of work corresponding to each scale point. The scale units are in METs from 1.5 (light work) to 10 (extremely strenuous work) (Mälkiä, 1996; Mälkiä et al., 1994). One MET represents the approximate rate of O<sub>2</sub> consumption of a seated individual at rest, which is 3.5 ml O<sub>2</sub> × kg<sup>-1</sup> × min<sup>-1</sup> (ACSM 2000; Howley, 2001). The frequency, duration and intensity of physical activity at work, commuting and leisure time physical activity, was measured using a 1-month all-time recall questionnaire. The responses were then converted to metabolic equivalent (MET) values with the aid of a specific computer programme (MetPro<sup>®</sup>). Time-weighted intensity average (TWA-MET) was calculated so that the sum of the MET-minutes of the activity categories in work time (OPA), leisure time (LTPA) and all activities time (work, commuting and LTPA together = AT) were divided by total time of the category (Mälkiä, 1996; Mälkiä et al., 1994). TWA represents the metabolic rate or intensity of physical activity (ISO/FDIS 8996, 2004). The maximum intensity of OPA, AT, LTPA was also analyzed. In our reliability study ( $n=14-16$ ) at weekly intervals, the test-retest intra-class correlation coefficients (ICC), according to Baumgartner (1989) scaling, varied between fair and high (time-weighted intensity average of LPTA (ICC 0.62) and AT (ICC 0.91), maximum intensity of LPTA (ICC 0.76) and AT (ICC 0.94)).

### 2.4. Ethics

The study was approved by the ethical committee of the University of Kuopio and the University Hospital of Kuopio.

### 2.5. Statistical analyses

We used cluster specific methods because departments rather than individuals were randomized. The effects of the intervention on the intensity of pain symptoms and muscle strength were analyzed using linear mixed models (Brown and Prescott, 1999; Goldstein, 1995). This approach has several advantages over traditional analyses using linear models such as ANOVA. First, the clustering effect of the department can easily be taken into account in the analysis (people within a certain department tend to be somewhat homogeneous). Second, there is no need to exclude any subject for whom complete data were not obtained, because the loss to follow-up process can be considered random. Third, it is possible to lighten the familiar assumption of equal error variances with mixed models.

The main advantage in cross-over designs is that the period of intervention and no-intervention is compared within subjects, that is, the response of a subject to an intervention will be contrasted with the same subject's response to no-intervention. Removing subject variation in this way makes cross-over trials potentially

more efficient than similar sized, parallel group trials in which each subject is exposed to only one treatment. In theory, exercise effects can be estimated with greater precision given the same number of subjects (Sibbald and Roberts, 1998).

The essential features of our cross-over design were modeled as fixed effects: main effects of treatment (intervention or no-intervention), treatment group (Treatment group 1, Treatment group 2), treatment period (autumn, spring) measurements within the treatment period (1–3), as well as their possible interactions. The random part of the model consisted of department effects, the effects of individuals within departments, as well as their (random) interactions with the fixed factors. The random part is required to account for the clustering effects of departments (on individuals) and of individuals (on repeated measurements) in order to obtain standard errors and significance tests that correctly reflect features of our design. Time spent performing light resistance training in the current 5-week period in minutes and the intensity of pain symptoms or upper extremity muscular strength in the baseline measurement were added into the model as covariates.

The model described above was first estimated and then evaluated separately for each of the three Pain Symptoms Groups. We then hierarchically simplified this original model as far as possible by removing the non-significant effects one by one, from the most complex least significant interactions. The model that could not be simplified any more, without dropping a significant effect or violating the hierarchy principle (i.e. non-significant lower-order effects cannot be removed if a significant higher-order interaction of same factors is present), was then evaluated against the original model using the Akaike information criterion (AIC) (Sakamoto et al., 1986). If it appeared to fit the data better than the original model, it was selected as the final one. Otherwise we used the original model.

The estimation and significance testing was carried out by utilizing the MIXED procedure of the SAS software (SAS, 1999), which involved using the restricted maximum likelihood (REML) estimation method (Patterson and Thompson, 1971) with related *F*-tests. The estimates from the final model were used in calculating the confidence intervals (CI) and significance tests for the effects of physical exercise interventions.

The effects of the physical exercise intervention on other physical activity performed outside the physical exercise intervention were evaluated with the same statistical principles as for the intensity of pain symptoms and muscular strength responses. We pre-specified all analyses on the intention-to-treat basis.

## 3. Results

### 3.1. Adherence to the physical exercise intervention in the Pain Symptoms Group

First, training session adherence, 75%, is the average percentage ratio of self-reported training sessions and guided training sessions. Second, the training adherence of 68% is the average percentage ratio of self-reported training time and guided target training time. The self-reported resistance training time was calculated according to the weekly training diary and the target training time was calculated according to the guided training frequency

Table 2  
Mean number of training sessions, mean training times in minutes and adherence percentage ratios during the intervention

Pain Symptoms Group (n = 53)	Light resistance training	
	Mean no. of training sessions	Mean training time in minutes
Periods	Self-reported/guided (adherence percentage)	Self-reported <sup>a</sup> /estimated target <sup>b</sup> (adherence percentage)
First	17/25 (68)	135/150 (90)
Second	29/35 (83)	149/210 (71)
Third	25/35 (71)	106/210 (50)
Average	24/32 (75)	130/190 (68)

<sup>a</sup> Light resistance training time in minutes during the intervention (15 weeks) in 5-week periods.

<sup>b</sup> Estimated target training time in minutes in 5-week periods: first period, 5 sessions × 6 min × 5 weeks = 150 min; second and third period, 7 sessions × 6 min × 5 weeks = 210 min.

and the average time spent being physically active in a single session (6 min). The mean number of training sessions, mean training times in minutes and adherence percentage ratios during the intervention are presented in Table 2. Third, guidance adherence is the percentage rate of

participation in three group sessions. According to our notes, 71% of the subjects participated two or three times in the training guidance sessions. Fourth, the measurements adherence of 83% was the average rate of returned Borg CR10 scale questionnaires. All the subjects received the intervention or no-intervention conditions they had been allocated.

3.2. The effects of physical exercise intervention on the intensity of headache and on the intensity of neck and shoulders symptoms among Pain Symptoms Sub-groups

The physical exercise intervention, resistance training and guidance together significantly decreased the intensity of headache ( $P=0.001$ ) in the Headache Symptoms Group and the intensity of neck symptoms ( $P=0.002$ ) in the Neck Symptoms Group. In the shoulder area, no significant effect of physical exercise intervention or light resistance training was found.

The estimated mean intensity of headache CR10 during the intervention was 0.66 (SE 0.19), and during the no-intervention period 1.29 (SE 0.19), mean difference was

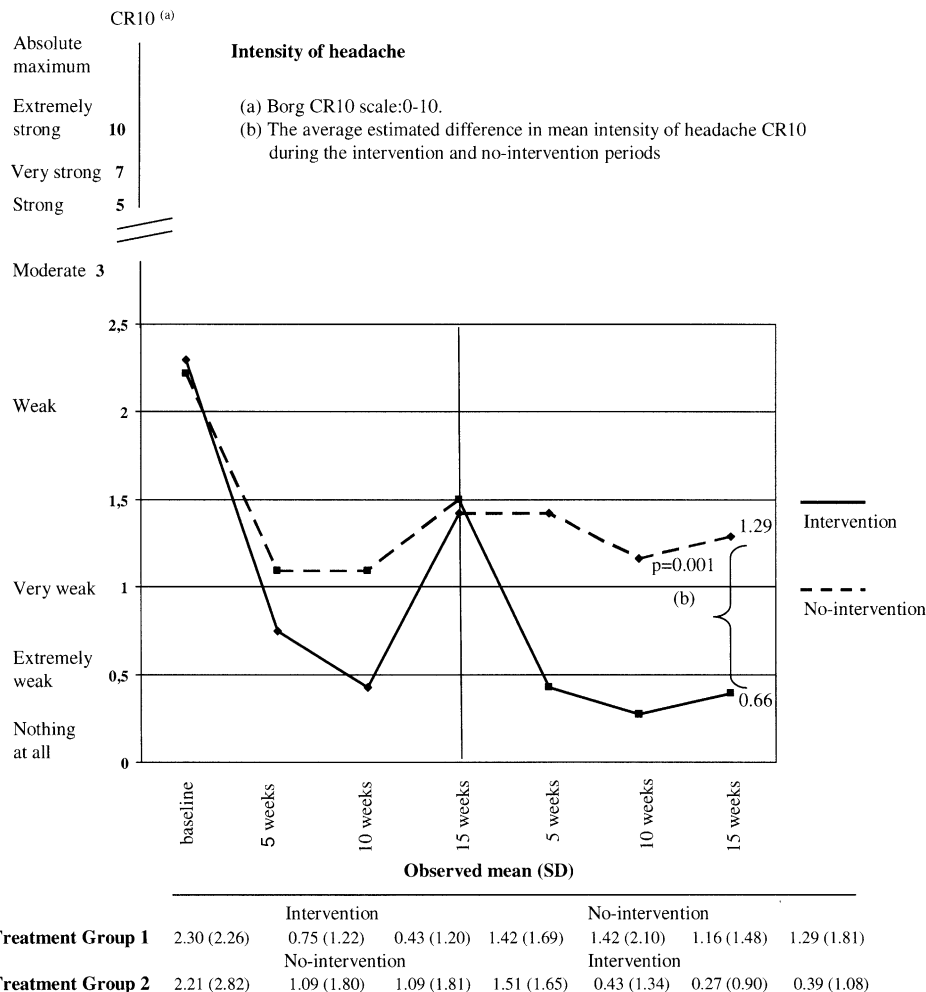


Fig. 2. Intensity of headache (CR10) during intervention and no-intervention.

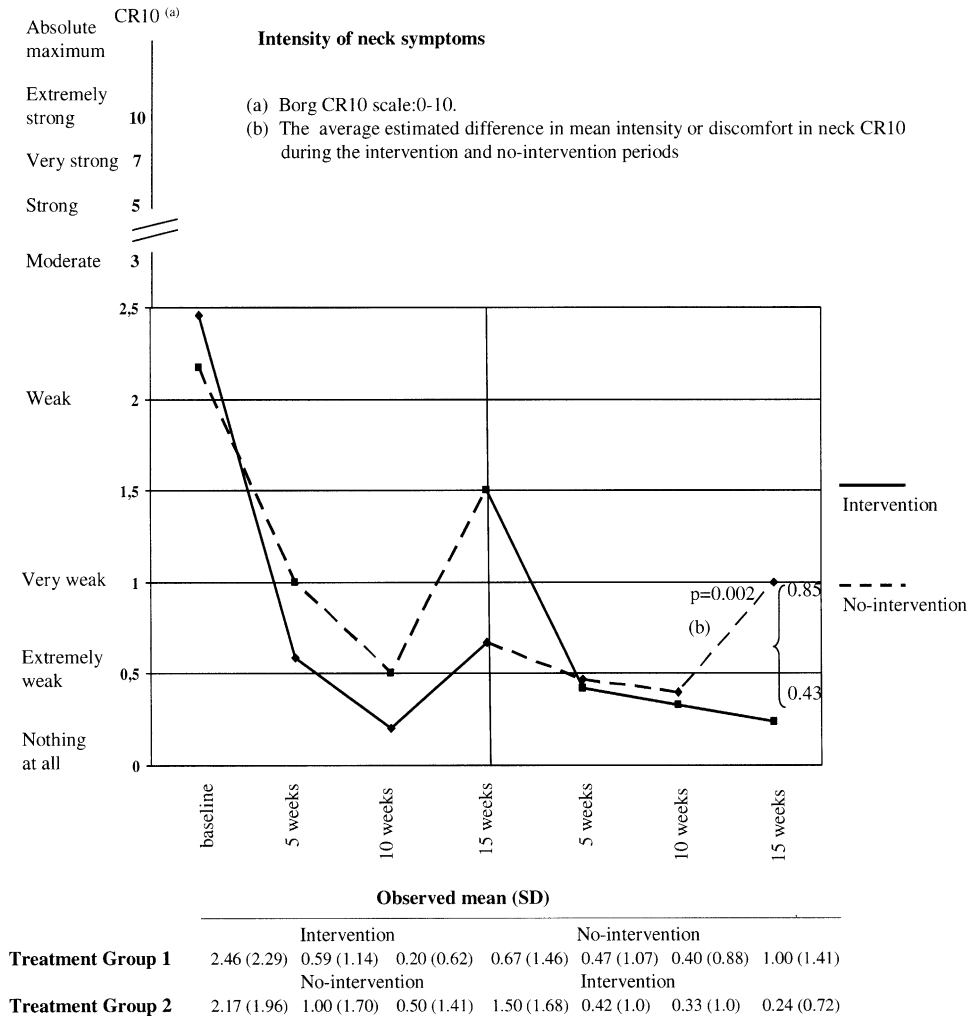


Fig. 3. Intensity of neck symptoms (CR10) during intervention and no-intervention.

0.64 CR10 (95% CI 0.28–1.00) (Fig. 2). Compared to the corresponding no-intervention period, the intervention led to a 49% (95% CI 22–77) decrease in intensity of headache. The estimated mean intensity of neck symptoms CR10 during the intervention was 0.43 (SE 0.15), and during the no-intervention period 0.85 (SE 0.16), mean difference was 0.42 CR10 (95% CI 0.11–0.72) (Fig. 3). Compared to the corresponding no-intervention period, the intervention led to a 49% (95% CI 13–85) decrease in intensity of neck symptoms. No harmful, health-related effects from the intervention were recorded.

### 3.3. The effects of physical exercise intervention on upper extremity muscular strength in the Pain Symptoms Group

Since the influence of the time spent performing light resistance training was statistically significant ( $P=0.001$ ), the training dose is more essential in increasing upper extremity extension strength than light resistance training and guidance together. In the Pain Symptoms Group ( $n=53$ ) the estimated mean in upper extremity extension

strength during the intervention was 37.4 kg (SE 0.5), and during the no-intervention period 36.1 kg (SE 0.5), mean difference was 1.3 kg (95% CI 0.5–2.1). Compared to the corresponding no-intervention period, the intervention led to a 4% (95% CI 1–6) increase in muscle strength. The average training time was 130 min over 5 weeks, an average of 26 min per week, and an average of 5 min per working day. In the upper extremity flexion strength, no significant effect of physical exercise intervention or light resistance training was found.

### 3.4. Control of physical and occupational health activities outside the physical exercise intervention in the Pain Symptoms Group

Excluding the light resistance training, the participants were asked to maintain the intensity and amount of their physical activity unchanged during the intervention and no-intervention periods. Also, no occupational health services were provided or the subjects were not initiated into new activities in occupational health and safety during the study.

Other physical activities were controlled using metabolic equivalent (MET) values. During the interventions, no statistically significant changes in physical activity were found in the time-weighted intensity average or maximum intensity of activity at work (OPA), leisure time physical activity (LTPA), or other physical activities (work, commuting and LTPA together = AT) in Treatment Groups 1 and 2. As the level of other physical activity performed was not statistically significant, this was not added as a covariate into the statistical model.

### 3.5. The analyses of clustering, carry-over, measurements and intervention period

We found no clustering effects of workplace in our data as all the random department effects were non-significant; department effects, the effects of individuals within departments, as well as their (random) interactions with the fixed factors. As the effect of physical exercise intervention was similar in all four departments, we were able to simplify the original hierarchy model by leaving the department level out of the model. In cross-over designs, the results of the latter intervention period may be contaminated by some transference from the earlier period. According to the statistical analyses, there were no carry-over effects in the pain or upper extremity extension strength measurements in our data: the effects of the treatment group (Treatment Group 1, Treatment Group 2), and the effect of measurements within the treatment groups, were not statistically significant. Since there was a carry-over effect in upper extremity flexion strength measurements, we analyzed these results according to the first training period as parallel group trials.

We assumed that in this study population learning effects did not play a significant role in intensity of pain measurements (CR10), because the main effect of the measurements was not statistically significant. Instead, positive learning effect ( $P=0.001$ ) was found in the upper extremity sub-maximal muscular strength tests. Intervention period was statistically significant: in the spring, the general intensity of neck symptoms was lower ( $P=0.043$ ) and both the extension ( $P=0.001$ ) and flexion ( $P=0.001$ ) strength of the upper extremities was higher than in the autumn.

### 3.6. Additional analyses

As the entire study group ( $n=90$ ) participated in the intervention and no-intervention periods, we were also able to analyze the Symptom-Free counterparts ( $n=37$ ) who did not meet the inclusion criteria. Among the Symptom-Free Group, we did not find any statistically significant intervention effects on the intensity of pain symptoms or the flexion strength of the upper extremities, but the time spent performing light resistance training increased the extension strength of the upper extremities ( $P=0.022$ ).

## 4. Discussion

The present study supports the findings of the previous studies that workplace-based physical exercise interventions can decrease neck symptoms in physically light work (Gronningsäter et al., 1992; Linton and van Tulder, 2001; Poper et al., 2003) and therapeutic exercise can decrease the intensity of symptoms in the neck area (Kjellman et al., 1999; Konijnenberg et al., 2001). Recently published therapeutic exercise studies among office workers are more contradictory. Ylinen et al.'s (2003) results provided support for our findings that active muscle training decreases neck symptoms, but Viljanen et al. (2003) did not support such results. In Ylinen et al.'s (2003) study, training adherence was high and their study results showed that the load and specificity of training movements were enough to increase neck muscular strength. In Viljanen et al.'s (2003) study, training adherence was low and muscular strength did not increase. In our study, the baseline values were relatively low, but a statistically significant level of alleviation occurred in the intensity of headache and intensity of neck symptoms. Also, changes in the extension strength of upper extremities and high rates of training and guidance adherence gives further support to our conclusion that light resistance training and guidance together can alleviate headache and neck symptoms among symptomatic office workers.

### 4.1. The content of physical exercise intervention

We specified the content of physical exercise interventions by adding the light resistance training variable in minutes as a covariate in the statistical model. Using this as a covariate, it was possible to distinguish between the effects of the light resistance training in minutes and the physical exercise intervention, which included light resistance training and guidance together, ignoring training time. Light resistance training time alone had no statistically significant effect on the intensity of headache or on the intensity of neck symptoms. Therefore, the reduced intensity of symptoms was a result of the combination of light resistance training and guidance. Conversely, the dose and specificity of training movements were sufficient to increase upper extremity extension strength. In fact, the effects of the time spent performing light resistance training cannot be assumed to be linear beyond the training levels observed in our data; averaging 130 min over 5 weeks, 26 min per week, and 5 min per working day.

### 4.2. Methodological quality and weaknesses of the study

The methodological quality of the present study, which was assessed according to the PEDro quality score and Cochrane Collaboration criteria (Koes and Hoving, 1998; Maher, 2000; van Tulder et al., 1997a,b) was lowered by

the fact that the subjects were not ‘blinded’. In physical exercise studies, it is very difficult to ‘blind’ subjects by including a placebo treatment, because a good and trustworthy placebo cannot be easily developed (Koes and Hoving, 1998). In light exercise training, in particular, the subjects cannot be made unaware that they have received treatment. Therefore, we maintain that physical exercise studies always include some non-specific effects, attraction or placebo effects. On the other hand, the strengths of the present study were careful documentation, especially in regard to the training dose (Hide and Bø, 1998), and control of other physical activity (Guyatt et al., 1993; Liddle et al., 2004), and possible confounding factors, such as department, learning, and seasonal effects. Moreover, the study was performed in the natural working environment.

Campbell et al. (2004) have noticed that the number of clusters is usually relatively small in cluster randomized trials, such as was the case in our study. Our primary interest, however, was focused on the individual level. The total number of individuals was large ( $n=90$ ), and even though the number of individuals in the Pain Symptoms Sub-groups was smaller ( $n=37-41$ ), cross-over trials are potentially more efficient than similar sized, parallel group trials.

#### 4.3. The clinical importance of changes in the intensity of pain symptoms and the generalization of the study findings

Our study shows that there is a statistically significant trend that light resistance training together with guidance results in an alleviation of headache and neck symptoms, and increases upper extremity extension strength. The statistically significant result does not necessarily mean that the change in pain symptoms was of clinical importance. The comparability of clinically important differences between our study and previous studies is difficult because of different study populations, pain measurements and interventions. However, according to previous studies, in less disabled populations even small changes can be clinically important (Farrar et al., 2000, 2001; Hägg et al., 2003).

As we were not able to control all non-specific effects, and as the samples were relatively small, care must be taken in generalizing the results of our study. To confirm these assumptions more randomized and controlled follow-up studies among different sedentary occupations and workplaces are required. There is the need to study the effects of different training doses and movements, using different training tools and guidance methods, to clarify the role of activities for coping with headache and neck and shoulder pain. Studies are also needed to explore the possibility that even slight positive changes in the intensity of pain symptoms could be relevant in preventing these symptoms from becoming chronic.

## 5. Conclusion

Light resistance training on a daily basis at the workplace with guidance can promote coping strategies in regards to the intensity of headache and neck symptoms, as well as increase the upper extremity extension strength of symptomatic office workers.

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