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# PHYSICAL EXERCISE AND HEALTH EDUCATION FOR NECK AND SHOULDER COMPLAINTS AMONG SEDENTARY WORKERS

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***Objective:*** **To assess the effectiveness of 3 different health promotion exercise programs for work-related shoulder and neck pain.**

***Design:*** **Comparative study design.**

***Subjects:*** **A total of 178 employees were recruited and grouped.**

***Methods:*** **Those in the "Self-exercise group" ($n = 56$) were given a lecture about the exercise program and then performed the program by themselves during their office break. "Team-exercise group I" ($n = 69$) performed the program once under the supervision of a physiotherapist after the lecture. "Team-exercise group II" ($n = 14$) performed the program twice; once under a physiotherapist's supervision. A modified Nordic questionnaire, pain threshold and cervical range of motion were used to evaluate the effect of intervention. There were 39 subjects in the reference group.**

***Results:*** **When daily change of pain threshold (post-work – pre-work) was treated as an improvement index, the odds ratios for the self-exercise group, team-exercise group I and team-exercise group II were 1.39, 4.63 ($p < 0.05$) and 7.06 ($p < 0.05$), respectively, compared with the reference group. A dose-response effect of intervention intensity was demonstrated.**

***Conclusion:*** **An intensive team-exercise program is beneficial in reducing neck and shoulder symptoms in sedentary workers.**

*Key words:* cumulative trauma disorders, arm, neck, exercise therapy.

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## INTRODUCTION

Load-elicited pain or discomfort over the neck and/or shoulder region associated with sedentary work is one of the major problems that physiotherapists deal with (1–4). The 1-year prevalence rate of experienced discomfort in this region can be 40% or more (5–7). In Taiwan, more than 60% of computer users had reversible symptoms, including eye soreness, thirst, dizziness and musculoskeletal disorders. The reported rate was as high as 100% for those working more than 6 hours per day (8). It is therefore critical to work towards prevention and early intervention before the pain becomes chronic, which may be accompanied by high medical costs.

During the past few decades, exercise-orientated intervention has been used widely and the experience of several hospital- or institute-based rehabilitation programs has shown the value of exercise in the reduction of neck and shoulder symptoms (9–11). However, intensive exercise programs often need specific therapeutic devices to provide better fixation and resistance during exercise (12) and these are usually not available in an ordinary workplace. On the other hand, the effect of a self-motivated program might be disappointing due to low compliance even though there are less medical resources required. Group exercise programs at the workplace may be a possible solution, but the quality of research in this field is mixed (13).

Hence, this study aimed to develop a workplace exercise program to alleviate neck and shoulder symptoms and to compare the effectiveness of 3 types of execution models.

## METHODS

### *Subjects*

Five departments in an airline company were selected to join this project and randomly assigned to reference and exercise groups. The employees in the same department were all placed in the same intervention program to avoid possible contamination from the neighbourhood. Announcement of an exercise training program specific to the neck and shoulder region was made through an introductory meeting for employees in the 5 departments. A total of 178 subjects who were interested in joining the exercise program were recruited and asked to sign a consent form. Their job characteristics were surveyed to determine the possible differences in physical loading among the groups. Employees in 4 of 5 departments were characterized by prolonged use of the computer (keyboard operators) and by answering the telephone using earphones. Employees in one department used keyboards less frequently during office hours.

There were 56 subjects in the "Self-exercise group" who performed the exercise by themselves during office breaks, with a physiotherapist (PT) available for consultation if any queries arose from the program. The subjects in "Team-exercise group I" ($n = 69$) carried out the exercise program once on a fixed daily schedule under the supervision and demonstration of a PT. There were 14 subjects in "team-exercise group II", who carried out the program twice, in the morning and afternoon. A PT also supervised 1 group exercise session for them. The reference group comprised 39 subjects who were only given the lecture.

Characteristics of the study sample are presented in Table I. The age of team-exercise group II ($49.6 \pm 8.7$ years) was significantly higher


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Table I. *Characteristics of study sample (*n *= 178)*

| | | | Team-exercise | |
|---|---|---|---|---|
| Characteristic | Reference group | Self-exercise group | Group I | Group II |
| Sample size, *n* | 39 | 56 | 69 | 14 |
| Gender (males, *n*) | 15 | 11 | 41 | 11 |
| Age, years (mean (SD)) | 37.2 (8)* | 37.9 (6.8)* | 41.2 (9.5)* | 49.6(8.7) |
| Age ≤40 years (*n*) | 26 | 37 | 32 | 2 |
| Age >40 years (*n*) | 13 | 19 | 37 | 12 |
| Company tenure, years (mean (SD)) | 8.15 (6.9)* | 9 (7.6) | 9.7(8.1) | 14.3(9.9) |
| Sought medical care (*n*) | | | | |
| In past year | 10 | 17 | 29 | 6 |
| In past week | 1 | 2 | 7 | 1 |

* ANOVA with Schefee test, significantly different from team-exercise group II, $p < 0.01$.

than the other 3 groups ($p < 0.05$). The mean average company tenure of team-exercise group II (14.3 ± 9.9 years) was also significantly longer than that of the reference group (8.15 ± 6.9 years). Both were treated as the adjusted factor in the regression model.

*Design*

As shown in Fig. 1, after the 1st-stage evaluation of baseline data collection, all participants attended a 2-hour lecture, which covered the anatomy of the neck and shoulder region, a demonstration of the exercise program, practice under supervision and recognition of feelings of discomfort that might be experienced during the stretching exercises. Meanwhile, a written description of the instructions was given to each subject to take home for reference. It was followed by a 2-week intensive exercise intervention with 3 different programs, as described above. Exercise programs included stretching exercises for tight muscles surrounding the neck region and exercise with a full range of cervical motion in 3 main planes including flexion, extension, side bending and rotation. Each movement was hold at the end of range for 5 seconds and repeated 10 times. On average, each session took approximately 15–20 minutes and this intensive exercise program was maintained for 2 weeks until the 2nd-stage evaluation was carried out. Subsequently, all subjects

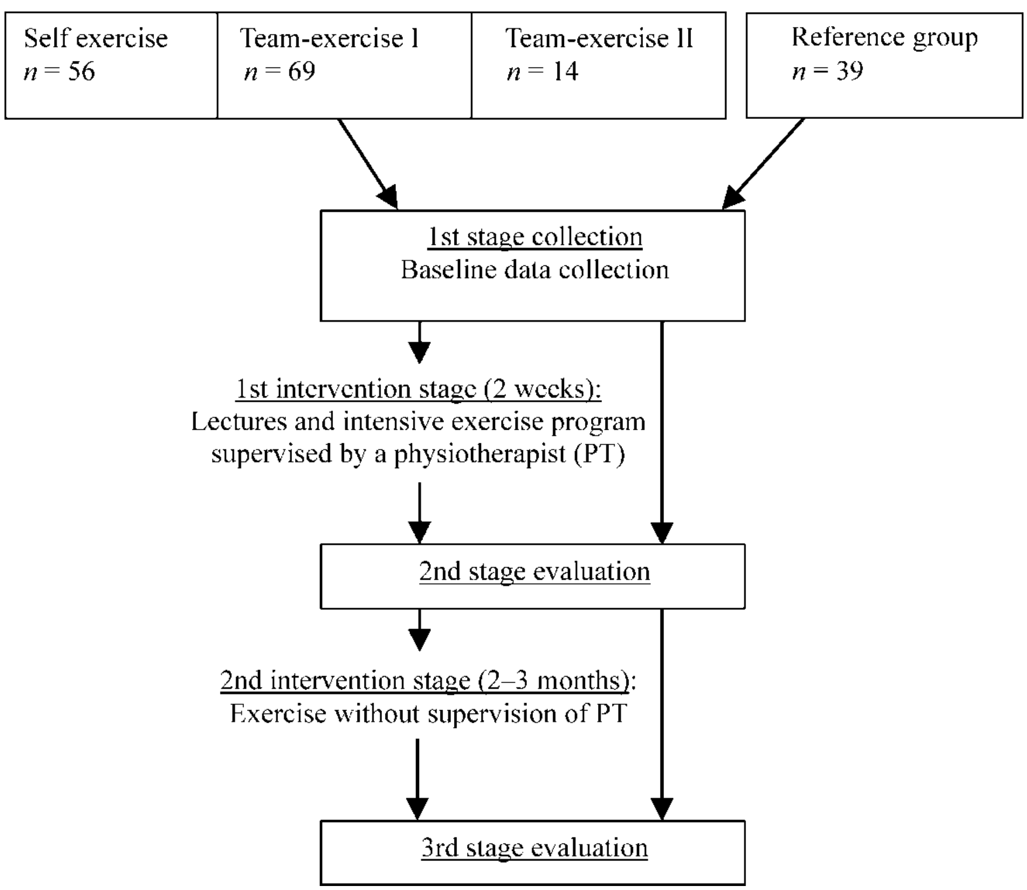


*Fig. 1.* Experimental design of the intervention programs. PT = physiotherapist.

except the reference group were encouraged to keep up their stretching exercises individually without the supervision of a PT for 2–3 months as a follow-up exercise period and then received the 3rd-stage evaluation.

*Outcome measures*

The evaluation included a modified Nordic questionnaire (14), pressure pain threshold (PPT) test and cervical mobility as active cervical range of motion (CROM). With the aim to clarify the effect of daily work stress, the latter 2 clinical physical examinations were assessed twice; before work (08.30 h) and after work (16.30 h) on a sampled day.

*Questionnaire.* All subjects answered the same questionnaire with the questions clarified by a therapist. The questionnaire was modified from the Nordic questionnaire by omitting the body chart and the box with questions. The questions were in text format and aimed to measure pain location, intensity, duration, disability, impairment, and medical consultation in the past 7 days and 12 months.

*Pressure pain threshold.* The pressure pain threshold (PPT) test was applied on the mid-point of the upper trapezius (from acromion to C7 spinous process) in both sides. Three repetitions were carried out in each evaluation session, whereas the first test was aimed to identify the discomfort threshold as the reference. There was a 20-second interval between each test. After comparing the PPT value of both sides, the side with lower PPT value indicated the higher tension of the muscle and was therefore defined as the affected side. The daily change in PPT in the affected side was computed by subtracting the post-work value from the pre-work value, and the lower the change the milder was the fatigue caused from daily work.

The pressure algometry used here has been suggested as a reliable method of measuring tender point sensitivity (15–17). The PPT was also found to differ between patients with symptoms and pain-free subjects, thus validating its use for assessment of muscle soreness (18).

*Cervical mobility.* Cervical mobility was assessed using an inclinometer device (CROM; Performance Attainment Associates, Roseville, MN, USA), which had been shown to be easy to use and which offers the capability of measuring CROM (19, 20). Each subject was seated in an upright chair and asked to keep the thoracic spine and trunk still. All of them practised each test movements 10 times in preparation for formal measurements, including flexion/extension, right/left side bending and right/left rotation. The maximal range of motion (ROM) in each direction was recorded in terms of degree, and the summation of 6 movements was defined as the total ROM. Similar to the PPT test, the daily change in total ROM was also computed to reflect the impact of work loading, and the greater the change the worse was cervical mobility.

*Statistical analysis*

The statistical significance of differences in the occurrence rate of complaints between the groups and phases was assessed using the chi-square test. Daily change of PPT and total CROM were tested by groups and stages with repeated one-way ANOVA with the significant limit at $p < 0.05$. In order to investigate the influence of 3 models of exercise program, multiple logistic regression models with adjustment of age and gender were applied. The dependent variable was the "improvement index", which is described below.

## RESULTS

### *Participant flow*

Twenty-three subjects (13%) dropped out of the study during the intensive exercise period; 22 of these were in the exercise group. Most of them were unable to receive the 2nd-stage evaluation due to their job or outside committments, which were not directly related to their neck and shoulder complaints. Another 17 subjects dropped out during the follow-up exercise period. In team-exercise group II, there were 3 subjects who missed the 2nd-stage evaluation but completed the 3rd-stage evaluation. A total of 141 subjects completed the 3rd-stage evaluation. To determine the effect of dropout subjects on the results, the same analyses for prevalence rate of soreness and data from clinical examination were also performed, with the data containing the dropouts in 2nd-stage and 3rd-stage evaluation. The results were essentially similar to those of subjects completing all 3 evaluations.

Table II. *Prevalence rates of reported soreness in past 1 week of the 3 stages*

| Group | Sample size | Reported soreness in past week (%) Neck | Shoulder | Upper back |
|---|---|---|---|---|
| *Reference group* | | | | |
| 1st stage | 39 | 48.6** | 35.1 | 18.9 |
| 2nd stage | 38 | 44.7 | 34.2 | 15.8 |
| 3rd stage | 29 | 44.8 | 48.3** | 20.7 |
| *Self-exercise group* | | | | |
| 1st stage | 56 | 58.5** | 37.7 | 28.3 |
| 2nd stage | 49 | 42.9 | 30.6 | 12.2* |
| 3rd stage | 48 | 33.3 | 14.6* | 14.6 |
| *Team-exercise group I* | | | | |
| 1st stage | 69 | 33.3 | 27.5 | 14.5 |
| 2nd stage | 59 | 32.2 | 23.7 | 5.1* |
| 3rd stage | 52 | 32.7 | 26.9 | 3.8** |
| *Team-exercise group II* | | | | |
| 1st stage | 14 | 14.3 | 14.3 | 7.1 |
| 2nd stage | 9 | 22.2 | 22.2 | 11.1 |
| 3rd stage | 12 | 25 | 8.3 | 25 |

* Chi-square with McNemar test: significantly different from the previous stage.
** Chi-square with Fisher's test within the same stage: significantly different from team-exercise group II.

### *Reported soreness in the 3 stages*

As presented in Table II, team-exercise group II was found to have a significantly lower rate of pain in the neck in the baseline, as well as the shoulder and upper back region in the 3rd-stage evaluation ($p < 0.05$) among the whole study groups.

As compared between stages within the group, in the self-exercise group there was a significant reduction in upper back soreness in the 2nd-stage evaluation ($p < 0.05$) and shoulder soreness in the 3rd-stage ($p < 0.05$).

### *Physical examination in the 3 stages*

A significant reduction in daily change in PPT in the affected side was noted in the self-exercise group at the end of the 2nd-stage exercise program (Table III). The same phenomenon was found in the reference group in the 3rd-stage. For team-exercise group II, the daily change in PPT on the same day was lower in the 2nd-stage, but did not reach a significant level.

In order easily to present the effect of intervention, a new indicator, improvement index, was used to define the workers who had experienced PPT improvement after receiving 2nd- and 3rd-stage evaluation. Those whose daily change of PPT value in the 2nd and 3rd stage was less than baseline were defined as the positive cases which meant that their perceived pain in the neck

Table III. *A summary of comparison of cervical range of motion (CROM) results of the groups given as mean values with SD within parentheses*

| Group | CROM difference (before work – after work) | Head protrusion (before work – after work) | Mean PPT of affected side (before work – after work) |
|---|---|---|---|
| *Reference group* | | | |
| 1st stage | 2.4 (30.3) | −0.3 (1.5) | 0.6 (1.1) |
| 2nd stage | 2.8 (30.5) | 0.2 (1.4) | 0.7 (1.2) |
| 3rd stage | −1.9 (22.5) | −0.5 (1.8) | 0.1 (1.0)† |
| *Self-exercise group* | | | |
| 1st stage | 5.5 (42.8) | 0.1 (1.8) | 0.8 (1.3) |
| 2nd stage | 10.3 (23.6) | −0.2 (1.6) | 0.6 (1.1) |
| 3rd stage | −2.3 (27.6) | −0.1 (1.1) | 0.1 (1.2) |
| *Team-exercise group I* | | | |
| 1st stage | −3.8 (26.6) | −0.6 (1.4) | 0.9 (1.6) |
| 2nd stage | 3.0 (32.1) | −0.3 (1.7) | 7.8E-03 (1.3)* |
| 3rd stage | 0.1 (21.5) | 4.1E-02 (1.5) | 0.3 (1.0) |
| *Team-exercise group II* | | | |
| 1st stage | −2 (52.8) | −5.4 (1.3) | 2 (2.6) |
| 2nd stage | −7 (20.9) | 0.1 (0.9) | −0.2 (2.2) |
| 3rd stage | 8.6 (25.9) | 0 (1.4) | 0.6 (1.3) |

* Significantly different from baseline data ($p < 0.017$).
SD = standard deviation. PPT = pressure pain threshold.

and shoulder region improved. All the others were defined as negative cases. Table IV summarizes the age- and gender-adjusted results of logistic regression models in which multiple factors were considered simultaneously. The odds ratio of getting improvement in 3 exercise groups in the 2nd-stage was: 1.39 (95% CI 0.59–3.27) in the self-exercise group, 4.63 (95% CI 1.89–11.81) in the team-exercise group I and 7.06 (95% CI 1.46–53.35) in team-exercise group II when reference group was 1, respectively. A similar trend was also observed in the 3rd-stage PPT and cervical mobility, but this was not significant.

## DISCUSSION

The results of PPT measurement provided a new plausible indicator of improvement in neck and shoulder functional ability. For the measurement daily change in PPT on the affected side, a significant reduction was found in 2nd- and 3rd-stage evaluation in team-exercise groups I and II ($p < 0.017$). Compared with the effect of exercise programs, it was noticed that the workers who performed exercise twice a day supervised by a PT were more likely to have significant improvement in muscle tone (OR = 7.07) in the 2nd-stage evaluation. Those who exercised once daily had a lower odds ratio of 4.63, while the self-exercise group had an insignificant odds ratio of 1.39. A clear dose-response relationship was observed in these 3 levels of exercise intensity. Lack of such an apparent pattern in 3rd-stage evaluation was somewhat within our expectations, since the subjects exercised by themselves without PT supervision and the duration between evaluations was prolonged to 3 months at most. Several recent studies have suggested that intensive exercise could reduce the discomfort or painful irritation of sedentary workers who need to use a computer for a long time (21, 22). The conclusion was supported by this study. In addition, this study demonstrated that such a workplace group exercise may be a good choice for symptom relief in neck and shoulder soreness since it is not an expensive program and no specific devices are needed. Also, the exercise does not need to take much time, and hence would not severely interrupt employee's work, which

Table IV. *Age-adjusted multiple logistic regression models of pressure pain thresholds (PPT) and cervical range of motion (CROM) improvement of the affected side. Odds ratio with 95% confidence interval*

| | PPT | | Cervical ROM | |
|---|---|---|---|---|
| | Improvement at 2nd-stage | Improvement at 3rd-stage | Improvement at 2nd-stage | Improvement at 3rd-stage |
| *Gender* | | | | |
| Female/male | 1.39 (0.7–3.29) | 0.97 (0.43–2.19) | 0.7 (0.44–1.74) | 1.39 (0.66–2.89) |
| *Group* | | | | |
| Reference group | 1 | 1 | 1 | 1 |
| Self-exercise group | 1.39 (0.59–3.27) | 1.16 (0.43–3.05) | 1.19 (0.10–2.77) | 1.38 (0.52–3.65) |
| Team-exercise group I | 4.63* (1.89–11.81) | 1.38 (0.52–3.56) | 1.07 (0.47–2.42) | 0.70 (0.29–1.66) |
| Team-exercise group II | 7.06* (1.46–53.35) | 1.32 (0.29–7.27) | 1.89 (0.48–8.4) | 1.42 (0.35–6.67) |

$p < 0.05$ (compared with the reference group within the same stage and the same measurement).

might result in lower compliance. It has been shown that only 1 or 2 stretch sessions of 15–20 minutes carried out during the workday can have a remarkable effect.

Active CROM measurement was not a sufficient tool of improvement in the current study. The low association between the measurements of PPT and CROM was also documented in the previous study (23). There are several possible reasons for this: the stretch exercise used here may have a temporary effect, which could be reflected in the reduction in daily change in PPT. Nonetheless, it is unlikely that such short-term exercise increases the CROM substantially; others factors include the effort and consistency of the subjects.

In our study, inconsistent results were observed among the 3 assessment tools used. PPT and a questionnaire appeared to be the possible predictors of perceived soreness status but ROM showed poor capacity to detect the change. This emphasized the importance of correlation between assessment and therapeutic approaches. For example, the stretching exercise might increase the flexibility of tight muscles. Subjects with some tight muscles around the neck might still have a full CROM because of compensation from other segments. Therefore, the ceiling effect will be expected if we used ROM to evaluate the efficacy of stretch exercise on these subjects. It is gradually being accepted that assessment of functional ability might be an important issue and would deserve more attention in future research (24–26).

The subjects were recruited from 5 departments in a company. Although the departments were chosen randomly from all the departments characterized by a sedentary occupation, the employees could refuse to join the program or could quit if they wished to do so.

In conclusion, it is worth initiating a lecture training and workplace group exercise as a health promotion program for workers who suffer from neck and shoulder soreness induced by a long-term sedentary sitting posture. A suitable exercise program may provide some welcome relief for workers, practitioners and policymakers.

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