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# Does Adapted Self-Exercise Have Benefits for Stiff Shoulders?

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**Purpose:** Stiff shoulders restrict shoulder motion and affect the quality of life. Several rehabilitation programs have been implemented to improve these conditions. Various exercises have been designed to achieve positive clinical outcomes. However, too many different sets of exercises can confuse patients and lead to infrequent exercises.

We aimed to compare the clinical outcomes of a small set of adapted self-exercises to a usual set in patients with stiff shoulders.

**Methods:** Seventy patients with stiff shoulders were randomly assigned to two groups, each performing self-exercises. Self-exercise in group I (the usual set) was composed of 'wall climbing in front,' 'wall climbing at the side,' and 'shoulder stretching with a towel,' and in group II (the adapted set), it was composed of 'assisted forward flexion stretching in the standing position,' 'sleeper stretching in the standing position,' and 'doorway or corner stretching.' The outcome measurements included pain score, functional score, and range of motion.

**Results:** There were no significant differences in the baseline patient characteristics between the groups in terms of sex (p=0.759), age (p=0.521), underlying disease (p=0.322), or body mass index (BMI) (p=0.687). Group II demonstrated significantly higher improvement in mean pain score decrement (-4.5±1.7 vs. -3.5±2.4, p=0.049), mean ASES score improvement (23.1±9.9 vs. 18.3±13.1, p=0.038) and mean degree improvement of shoulder motion in all directions than in group I.

**Conclusions:** The adapted self-exercise set may offer favorable results in treating patients with stiff shoulders and may also be a treatment option for overweight patients.

**Keywords:** Stiff shoulder, Adhesive capsulitis, Frozen shoulder, Sleeper stretch

A common clinical condition is a stiff shoulder, also referred to as adhesive capsulitis or frozen shoulder. This condition restricts shoulder motion and affects the quality of life. The cause of stiff shoulders is not clearly understood, and the exact duration of recovery from this condition is uncertain[2]. Management of stiff shoulders usually begins with nonoperative interventions, including medication, self-stretching exercises, and physical therapy. Different centers have used many rehabilitation programs, and multiple studies have demonstrated improved outcomes[5,7,12,13].

During the COVID-19 pandemic, hospital policies to reduce contamination made treating stiff shoulders more difficult. Self-stretching exercises for improving the mobility of joints and decreasing pain have become a useful treatment. Some studies indicated that self-exercise is more important than

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physical therapy in the hospital, and the effectiveness of self-exercise depends on its frequency(17). In many institutions, a specific group of exercises has been used for patients with stiff shoulders, such as 'wall climbing,' 'shoulder stretching with a towel,' 'sleeper stretching,' 'active assisted shoulder forward flexion with a wand,' 'active assisted shoulder external rotation with a wand,' and 'pendulum exercise,' but no study has demonstrated which exercises are superior(3,5,7,12,13,17). Despite the positive results of many sets of exercises, the large number of self-exercises can be confusing for patients and may result in low compliance. This study used a small set of self-exercises that the physician modified for convenience, called an adapted set.

This study aimed to investigate the benefits of the adapted set of self-exercises in patients with stiff shoulders and demonstrate the better outcome of the adapted set of self-exercises compared to the usual set of self-exercises.

## MATERIALS AND METHODS

After receiving approval from our hospital's Ethics Committee, 70 patients were recruited for this study. The inclusion criteria were as follows: 1) age >40; 2) diagnosis of stiff shoulder, adhesive capsulitis, or frozen shoulder; 3) limited range of motion of the shoulder in all directions; 4) consent to be examined by plain radiography; 5) agreement to self-exercise as a treatment for stiff shoulders; and 6) ability to communicate. The exclusion criteria were as follows: 1) history of serious injury or arthrosis of the shoulder, 2) planned pregnancy, 3) serious acute inflammation or infection of the shoulder, 4) bleeding tendency, and 5) inability to participate in the study. A single sports medicine-trained physician participated in this study. The patients were randomly assigned to Groups I and II, alternating according to the order of visits (n=35 in each group). The patients in each group were not informed of the treatment options in the other groups.

### *Intervention*

In this study, self-exercises were selected by using a group of exercises that are commonly used for rehabilitation as home self-exercises, consisting of 'wall climbing in front,' 'wall climbing at the side,' and 'shoulder stretching with a towel,' which are called the usual set and were assigned to group I (Figure 1). Another set of self- exercises was selected by combining three exercises used by sports medicine physicians. To cover shoulder motion, selected self-exercises included 'overhead reach,' 'sleeper stretching,' and 'doorway or corner stretching'(11). In this study, some exercises were adjusted from lying to standing for convenience. Therefore, this set of exercises was called the adapted set and assigned to Group II (Figure 2).

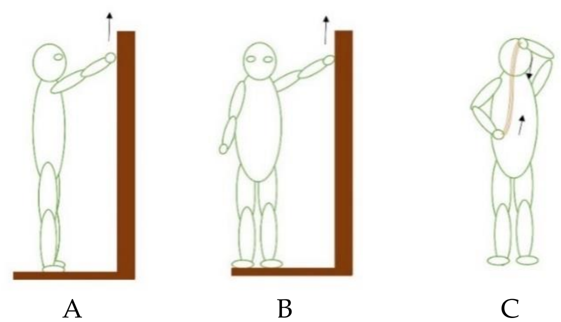


**Fig. 1** Exercise in Group I, the usual set: A = wall climbing in front; B = wall climbing at the side; C = shoulder stretching with a towel.

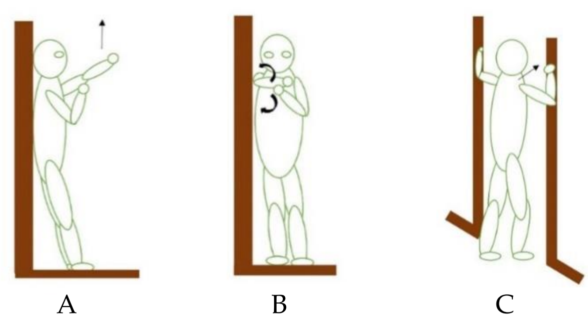


**Fig. 2** Exercise in Group II, adapted set: A = assisted forward flexion stretching in the standing position; B = sleeper stretching in the standing position; C = doorway or corner stretching.

The instructions for self-exercise were as follows:

- Wall climbing in front: The patient stands facing a wall. They place the hand of the affected shoulder on the wall and climb as far as possible.
- Wall climbing on the side: The patient stands with the affected shoulder facing the wall.

They place their hand on the wall and climb as far as possible.

- Shoulder stretching with a towel: The patient is standing, and the hand of the opposite shoulder is used to hold the towel behind the back. They should hold the lower end with the hand of the affected shoulder and use the other hand to lift the towel as far as possible (Figure 1).
- Assisted forward flexion stretching in the standing position: The patient stands with their back against the wall, a foot away from the wall, approximately one step. They raise the arm of the affected shoulder upward to the ceiling and use the other hand to push the arm as gently as possible.
- Sleeper stretching in the standing position: The patient stands with the affected side against a wall. They raise the arm straight out from the shoulder, bend the elbow, and maintain it in a L-position. The other hand is used to push the forearm of the affected shoulder up and down toward the wall as far as possible.
- Doorway or corner stretching: The patient stands in an open doorway or corner, raising each arm to the side and bent at 90-degree angles with the palms on the door frame or wall. They slowly step forward with one foot and feel the stretch of the shoulders (Figure 2).

The participants were held at the farthest point of each exercise for 20 s. This was repeated ten times per session for six sessions per day. Each patient was given a pamphlet with instructions for self-exercise and received coaching from a physician. In both groups, nonsteroidal anti-inflammatory drugs or analgesics were prescribed as necessary.

### *Outcome Measurements*

All patients were re-examined at one-month intervals for up to three months. At each visit, the physician reassessed the set of exercises, pain scores, shoulder function, and passive shoulder range of motion. Shoulder function was assessed using the Thai version of the ASES (American Shoulder and Elbow Surgeons) Score, which is reliable[14]. In the standing position, the shoulder range of motion was assessed by asking the patient to move the arm in the desired direction and verifying the absence of muscle weakness by having the examiner push the arm further in that direction. A universal goniometer is then used to measure multiple directions, such as forward flexion, abduction, adduction, extension, internal rotation, and external rotation of the side [6,9]. Data on pain, ASES score, and range of motion were used for outcome analysis.

The primary endpoints were the effects of two small sets of self-exercises on pain, shoulder function (ASES score), and range of motion. The secondary endpoint was the relationship between patient characteristics regarding pain, shoulder function, range of motion, and self-exercise.

### *Sample Size*

The sample size was calculated by using GPower to estimate the sample sizes for a two-sample means test using $\alpha$= 0.05, the power of the test= 80%, the confidence level= 95%, mean1= 0.80, mean2= 0.10, and the standard deviation= 1.00. The minimum sample size was 34 patients in each group (at least 68 patients). Data were analyzed using SPSS, Inc., released in 2009, PASW Statistics for Windows, Version 18.0. Chicago: SPSS, Inc. An independent t-test was used to compare differences in the change in pain scores between the two groups. A dependent t-test was used to compare differences in pain scores between the initial and final measurements. Multivariate analysis was used to analyze the relationship between the delta ASES score and the variables, delta pain, and the variables in the Gaussian regression model. The chi-square test was used to compare significantly different baseline characteristics between the two groups. $P < 0.05$ was considered to indicate statistical significance.

## RESULTS

Seventy patients (57 women, 13 men) were enrolled in this study. None of the patients were lost to follow-up. According to the demographic data analysis, there was no significant difference between the usual-set and adapted-set groups in baseline characteristics such as sex (p=0.759), age (p=0.521), BMI (p=0.687), handedness (p=0.555), and underlying diseases, such as diabetes (p=0.607), hypertension (p=0.803), and dyslipidemia (p=0.051) (Table 1).

The baseline pain score in group II was significantly higher than in group I (p=0.046). The ASES score was significantly higher in group II (p=0.043). The baseline shoulder range of motion showed no significant difference, except for extension, which was significantly lower in group II (p=0.006).

After intervention, the mean pain score significantly decreased in both groups. The pain score in group I decreased from 6.3 ± 2.1 to 2.8 ± 1.8 (p<0.001), and that in group II decreased from 7.1 ± 1.5 to 2.7 ± 1.2 (p<0.001). However, the mean pain score decrement in group II (-4.5 ± 1.7) was significantly better than in group I (-3.5 ± 2.4) (p=0.049) (Table 2). The ASES score also demonstrated significant improvement in group I (from 41.1 ± 2.6

**Table 1** Baseline characteristics of patients in the study between groups by set of self-exercises.

| | **Group I (usual set)** | | **Group II (adapted set)** | | **p-value** |
|---|---|---|---|---|---|
| | **(n = 35)** | **(%)** | **(n = 35)** | **(%)** | |
| **Gender** | | | | | 0.759 |
| Male | 6 | 17.1 | 7 | 20.0 | |
| Female | 29 | 82.9 | 28 | 80.0 | |
| **Handedness** | | | | | 0.555 |
| Right | 34 | 97.1 | 33 | 94.3 | |
| Left | 1 | 2.9 | 2 | 5.7 | |
| **Affected shoulder** | | | | | 0.094 |
| Right | 13 | 37.1 | 20 | 57.1 | |
| Left | 22 | 62.9 | 15 | 42.9 | |
| **Underlying disease** | | | | | 0.322 |
| Yes | 20 | 57.1 | 24 | 68.6 | |
| No | 15 | 42.9 | 11 | 31.4 | |
| Diabetes | 10 | 28.6 | 12 | 34.3 | 0.607 |
| Hypertension | 13 | 37.1 | 12 | 34.3 | 0.803 |
| Dyslipidemia | 10 | 28.6 | 18 | 51.4 | 0.051 |
| Kidney disease | 1 | 2.9 | 0 | 0 | 0.314 |
| **Age** (min–max) (yrs.) | 44 – 79 | | 43 – 75 | | |
| $\bar{x}$ ± SD | 61.2 ± 9.1 | | 59.8 ± 8.7 | | 0.521 |
| <65 yrs. | 22 | 62.9 | 24 | 68.6 | 0.615 |
| ≥65 yrs. | 13 | 37.1 | 11 | 31.4 | |
| **Body Mass Index** (BMI) (kg/m2) | 19.3 – 33.9 | | 19.0 – 35.8 | | |
| $\bar{x}$ ± SD | 25.9 ± 3.7 | | 25.5 ± 4.3 | | 0.687 |
| < 23 | 6 | 17.1 | 11 | 31.4 | 0.163 |
| ≥ 23 | 29 | 82.9 | 24 | 68.6 | |
| **Pain score** | | | | | |
| $\bar{x}$ ± SD | 6.3 ± 2.1 | | 7.1 ± 1.5 | | 0.046* |
| **ASES score** | | | | | |
| $\bar{x}$ ± SD | 41.1 ± 15.8 | | 48.1 ± 12.5 | | 0.043* |
| **Range of motion of affected shoulder** ($\bar{x}$ ± SD) | | | | | |
| Forward flexion | 90.3 ± 21.3 | | 96.4 ± 23.2 | | 0.260 |
| Abduction | 64.7 ± 16.6 | | 73.5 ± 25.7 | | 0.092 |
| Adduction | 13.2 ± 9.7 | | 14.5 ± 9.9 | | 0.593 |
| Extension | 33.5 ± 9.1 | | 27.9 ± 7.4 | | 0.006* |
| Internal rotation | 35.6 ± 12.5 | | 35.2 ± 13.8 | | 0.899 |
| External rotation | 29.1 ± 16.8 | | 31.7 ± 14.2 | | 0.482 |

*p<0.05, considered statistically significant to 59.3 ± 13.6) and group II (from 48.1 ± 12.5 to 71.2 ± 10.8) ($p<0.001$). Nevertheless, group II showed a significantly higher mean ASES score improvement ($p=0.038$) than group I (Table 3).

Both groups showed significant improvements in the range of motion in forward flexion, abduction, adduction, extension, internal rotation, and external rotation ($p<0.001$). Compared with group I, group II showed a significantly higher mean degree of improvement in all directions ($p\leq0.001$) (Table 4)

**Table 2** Pain score improvement between groups by set of self-exercises.

| | Group | Within group | | | Between group | |
|---|---|---|---|---|---|---|
| | | **Pre ($\bar{x}$ ± SD)** | **Post ($\bar{x}$ ± SD)** | **p-value** | **Mean pain score decrement** | **p-value** |
| **Pain score** | I (usual set) | 6.3 ± 2.1 | 2.8 ± 1.8 | p<0.001* | -3.5 ± 2.4 | p=0.049* |
| | II (adapted set) | 7.1 ± 1.5 | 2.7 ± 1.2 | p<0.001* | -4.5 ± 1.7 | |
| | | p=0.046* | p=0.758 | | | |

*p<0.05, considered statistically significant

**Table 3** ASES score improvement between groups by set of self-exercises.

| | Group | Within group | | | Between group | |
|---|---|---|---|---|---|---|
| | | **Pre ($\bar{x}$ ± SD)** | **Post ($\bar{x}$ ± SD)** | **p-value** | **Mean ASES score improvement** | **p-value** |
| **ASES score** | I (usual set) | 41.1 ± 2.6 | 59.3 ± 13.6 | p<0.001* | 18.3 ± 13.1 | p=0.038* |
| | II (adapted set) | 48.1 ± 12.5 | 71.2 ± 10.8 | p<0.001* | 23.1 ± 9.9 | |
| | | p=0.043* | p<0.001* | | | |

*p<0.05, considered statistically significant

**Table 4** Range of motion improvement between groups by set of self-exercises.

| | Group | Within group | | | Between group | |
|---|---|---|---|---|---|---|
| | | **Pre ($\bar{x}$ ± SD)** | **Post ($\bar{x}$ ± SD)** | **p-value** | **Mean degree improvement** | **p-value** |
| **Forward flexion** | I (usual set) | 90.3 ± 21.3 | 111.2 ± 20.7 | p<0.001* | 20.9 ± 13.5 | p<0.001* |
| | II (adapted set) | 96.4 ± 23.2 | 139.2 ± 24.9 | p<0.001* | 42.9 ± 21.2 | |
| **Abduction** | I (usual set) | 64.7 ± 16.6 | 85.3 ± 24.3 | p<0.001* | 20.6 ± 15.7 | p<0.001* |
| | II (adapted set) | 73.5 ± 25.7 | 125.7 ± 26.9 | p<0.001* | 52.2 ± 28.3 | |
| **Adduction** | I (usual set) | 13.2 ± 9.7 | 21.5 ± 10.6 | p<0.001* | 8.3 ± 6.7 | p=0.001* |
| | II (adapted set) | 14.5 ± 9.9 | 30.9 ± 9.7 | p<0.001* | 16.5 ± 11.7 | |
| **Extension** | I (usual set) | 33.5 ± 9.1 | 42.5 ± 9.4 | p<0.001* | 9.0 ± 8.1 | p<0.001* |
| | II (adapted set) | 27.9 ± 7.4 | 45.7 ± 5.2 | p<0.001* | 17.8 ± 7.8 | |
| **Internal rotation** | I (usual set) | 35.6 ± 12.5 | 47.9 ± 13.4 | p<0.001* | 12.3 ± 8.0 | p<0.001* |
| | II (adapted set) | 35.2 ± 13.8 | 58.6 ± 8.1 | p<0.001* | 23.4 ± 10.8 | |
| **External rotation** | I (usual set) | 29.1 ± 16.8 | 44.5 ± 18.8 | p<0.001* | 15.5 ± 11.2 | p=0.001* |
| | II (adapted set) | 31.7 ± 14.2 | 57.9 ± 15.7 | p<0.001* | 26.3 ± 13.6 | |

*p<0.05, considered statistically significant

**Table 5** Comparison between groups by set of self-exercise, subclassified by BMI, gender, age, and affected shoulder.

| | Group | Mean pain score decrement | Mean ASES score improvement | Range of motion (Mean degree improvement) | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Forward flexion | Abduction | Adduction | Extension | Internal rotation | External rotation |
| **BMI<23** | I (usual set) (N=6) | -3.7±1.5 | 18.3±7.5 | 15.3±18.6 | 20.0±19.6 | 10.2±9.0 | 5.0±9.3 | 9.5±11.5 | 8.8±11.1 |
| | II (adapted set) (N=11) | -3.9±1.6 | 20.3±9.5 | 44.8±19.8 | 53.4±22.1 | 14.6±8.6 | 15.8±7.9 | 22.4±10.6 | 25.6±12.2 |
| | p-value | p=0.769 | p=0.673 | p=0.009* | p=0.008* | p=0.329 | p=0.023* | p=0.035* | p=0.014* |
| **BMI≥23** | I (usual set) (N=29) | -3.5±2.5 | 18.3±14.1 | 22.1±12.3 | 20.8±15.2 | 7.9±6.3 | 9.9±7.7 | 12.9±7.3 | 16.9±10.8 |
| | II (adapted set) (N=24) | -4.8±1.8 | 24.4±10.0 | 42.0±22.2 | 51.7±31.2 | 17.3±13.0 | 18.7±7.7 | 23.9±11.0 | 26.6±14.5 |
| | p-value | p=0.039* | p=0.081 | p<0.001* | p<0.001* | p=0.001* | p<0.001* | p<0.001* | p=0.007* |
| **Male** | I (usual set) (N=7) | -2.9±3.8 | 14.3±18.8 | 20.6±17.0 | 16.6±19.5 | 7.4±6.8 | 8.3±8.3 | 14.3±8.3 | 16.4±14.6 |
| | II (adapted set) (N=6) | -5.0±1.3 | 27.5±11.7 | 61.0±21.4 | 63.3±18.1 | 15.5±22.1 | 19.8±6.5 | 27.5±11.4 | 33.7±6.6 |
| | p-value | p=0.212 | p=0.165 | p=0.003* | p=0.001* | p=0.375 | p=0.019* | p=0.034* | p=0.022* |
| **Female** | I (usual set) (N=28) | -3.6±2.0 | 19.3±11.5 | 21.0±12.8 | 21.6±14.9 | 8.5±6.8 | 9.2±8.2 | 11.8±8.1 | 15.3±10.5 |
| | II (adapted set) (N=29) | -4.4±1.8 | 22.2±9.5 | 39.1±19.5 | 49.9±29.7 | 16.7±8.9 | 17.4±8.0 | 22.6±10.7 | 24.7±14.3 |
| | p-value | p=0.148 | p=0.305 | p<0.001* | p<0.001* | p<0.001* | p<0.001* | p<0.001* | p=0.006* |
| **Age<65 yrs.** | I (usual set) (N=22) | -3.8±1.9 | 20.5±11.4 | 19.4±13.5 | 23.6±13.8 | 9.6±6.8 | 10.6±7.4 | 12.2±8.2 | 15.1±11.9 |
| | II (adapted set) (N=24) | -4.8±1.7 | 24.3±8.9 | 44.7±23.5 | 53.7±30.8 | 19.5±8.7 | 18.7±8.8 | 24.4±10.4 | 26.3±13.8 |
| | p-value | p=0.072 | p=0.210 | p<0.001* | p<0.001* | p<0.001* | p=0.002* | p<0.001* | p=0.006* |
| **Age≥65 yrs.** | I (usual set) (N=13) | -2.9±3.1 | 14.6±15.3 | 23.5±13.6 | 15.7±18.1 | 6.1±+6.1 | 6.3±8.8 | 12.5±8.2 | 16.1±10.4 |
| | II (adapted set) (N=11) | -3.8±1.7 | 20.5±11.7 | 38.9±15.3 | 48.9±22.9 | 9.7±14.8 | 15.9±4.7 | 21.2±11.9 | 26.3±14.0 |
| | p-value | p=0.397 | p=0.313 | p=0.016* | p=0.001* | p=0.426 | p=0.004* | p=0.045* | p=0.053 |

*p<0.05, considered statistically significant

According to the BMI criteria for Asians, patients in both groups were divided into normal weight (BMI <23 kg/m$^2$) and overweight (BMI ≥23 kg/m$^2$) subgroups[10]. Group II showed a significant decrease in the pain score compared to group I in patients with BMI ≥23 kg/m$^2$ (p=0.039). It also showed a significant improvement in range of motion in patients with a BMI ≥23 kg/m$^2$, which was better than that in those with a BMI <23 kg/m$^2$.

There were no significant differences between males and females. It also showed no difference between the patients who were <65 and ≥65.

## DISCUSSION

This study investigated the effects of a small group of exercises on patients with stiff shoulders. Seventy patients were divided into two groups, and a small set of self-exercises was assigned to each group: the usual set for Group I and the adapted set for Group II. In both groups, a small set of self-exercises produced significantly better results regarding pain score, functional score, and shoulder range of motion. In group II, significant improvements in pain score (p=0.049), functional score (p=0.038), and shoulder range of motion (p≤0.001) were observed compared with group I. This may be due to self-exercise patterns. The assisted passive stretching exercise in Group II may have a better effect on the stretching of the joint capsule than the exercise in Group I. Wall climbing in front and wall climbing at the side in Group I may involve moving the body to help raise the arms higher more than moving the shoulder joint alone. While the assisted forward flexion stretching in Group II, which involves standing with the back to the wall, may assist in preventing the body from moving, the shoulder joint may stretch more as a result of this than it did in Group I. Sleeper stretching helped to improve range of motion by stretching the posterior capsule and musculature, according to a study by Laudner *et al*.[8], and doorway stretching stretched the structure on the front of the shoulder joint.

Sleeper stretching has shown significant improvement in range of motion and is advantageeous for treating stiff shoulders. Chidambaram *et al*. reported that sleeper stretching and manual mobilization improved range of motion and pain scores[4]. Sule *et al.* demonstrated that sleeper stretching performed by therapists improved shoulder ranges of flexion, extension, internal rotation, and adduction but did not improve pain and function[16]. Sleeper stretching was limited by the space required because it had to be performed in a lying position. In this study, the pattern of self-exercise in Group II was adapted to be more convenient by adjusting the overhead reach and sleeper stretching exercise from a lying position to a standing position, demonstrating a better result than in Group II.

Subgroup analysis revealed that the adapted set of exercises had better effects than the usual set in patients with a BMI ≥23 kg/m² in terms of pain score, functional score, and shoulder range of motion. A thick torso may impede certain self-exercises in the overweight group, such as shoulder stretching with a towel. This is because, at the beginning of the exercise, the hand of the affected shoulder must be placed behind the back. Therefore, sleeper stretching in the standing position, which puts the arm in front, maybe more advantageous. Barbosa et al. reported that 53% of patients with a BMI >30 did not respond to conservative treatment and underwent arthroscopic surgery[1]. No studies have focused on the effects of self-exercise in patients with obesity. According to the findings of this study, the adapted set of self-exercises improved pain, range of motion, and shoulder function, and patients with a BMI ≥23 kg/m² benefited from the adapted set of self-exercises.

This study had some limitations. First, a small number of patients treated by a single physician may not represent the general Thai population. Secondly, the physicians who treated the patients were not blinded to the study.

## CONCLUSIONS

According to the findings, the adapted self-exercise set may offer favorable results in treating patients with stiff shoulders and may also be a treatment option for overweight patients.

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