

Modified wall-stretching exercises: A practical strategy to promote an immediate effect of shoulder flexibility

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ABSTRACT

Background: The decreased flexibility could attribute numerous adverse impacts to daily functions and risk of joint injury, especially in the joint with a large range of motion (ROM), such as that of the shoulder. Current management to increase shoulder flexibility mostly face the problems of regular adherence due to the need for expert guidance and the requirement of specific and numerous poses that are difficult to remember and time-consuming.

Objective: To investigate the immediate effects of the modified wall-stretching exercise on shoulder flexibility using a quasi-experimental design. Moreover, the study explored the proportion of arms (dominant and non-dominant) with limited shoulder flexibility.

Materials and methods: Fifty-six participants (38 females, 68%) with limited shoulder flexibility as determined using the back scratch test performed a modified wall-stretching exercise. The method required the participants to place their hands against the wall at the shoulder levels with elbow and wrist extensions while the hands were in three positions: upward, sideward, and downward. Participants moved the upper trunk downward and held at the maximal stretch position for 15 seconds in each hand position. After a sufficient rest period, participants were re-assessed for their shoulder flexibility using the back scratch test. The paired samples t-tests were used to analyze the study findings.

Results: Most participants had limited shoulder flexibility in both arms (N=35, 63%), especially in the non-dominant arm (60%). Immediately after 45 seconds of a modified wall-stretching exercise, participants significantly improved their shoulder flexibility by approximately 3 cm ($p < 0.001$).

Conclusion: The limited shoulder flexibility, particularly on the non-dominant arm, suggests that a sedentary lifestyle, characterized by spending the most time in a flexed posture using social media, may have contributed to reduced muscle strength, particularly in the non-dominant arm when performing overhead activities. The present findings suggest using a modified wall-stretching exercise as an alternative practical, self-administering, and effective method to promote shoulder flexibility that can be applied easily in various settings.

Introduction

Flexibility is an intrinsic property of the body's soft tissues (i.e., muscles and connective tissues) that determines the range of motion achievable without injury at a joint or group of joints.¹ Thus, the ability of a joint or series of joints to move through an unrestricted, pain-free range of motion while executing daily activities is essential.^{2,3} Optimal flexibility also prevents injuries,

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promotes motor performance, and maintains overall physical health.^{4,5} On the contrary, the decreased flexibility, due to several causes (e.g., improper use of the joints in daily activities, sedentary lifestyle inducing muscle weakness, abnormal posture, and system decline due to age advancement), could be attributed adverse impacts to daily functions and risk of joint injury.⁶⁻⁹ This is particularly true for a joint with an extensive range of motion (ROM), such as that of the shoulder, whereby its ROM allows various movements covering overhead reaching, combing hair, and hand behind the back. Consequently, numerous protocols have been proposed to maintain, improve, and manage problems affecting shoulder flexibility.

Current management to increase shoulder flexibility can be done through active and passive stretching exercises, either as a self-management protocol or by an expert, such as static, dynamic, and ballistic stretching protocols.¹⁰⁻¹⁷ However, most of these methods often pose challenges for regular adherence due to the need for expert guidance and the requirement of specific and numerous poses that are difficult to remember and time-consuming.^{13,18,19} Consequently, exploring an alternative practical method to promote shoulder flexibility is needed, especially in a current era of stress, competition, and sedentary lifestyles with spending the most time on a computer and social media.

In general, an exercise protocol to increase joint flexibility can be done by fixing one end and moving the other end of the soft tissues surrounding the joint. Considering the characteristics of muscles and soft tissues surrounding the shoulder joint, they all travel, covering the joint with the attachment between the upper trunk and arms.^{6,20,21} Thus, the techniques to improve shoulder flexibility can be done by moving the arm while fixing the trunk or vice versa with the assistance of the other arm or external force. In addition, shoulder flexibility can be achieved through self-stretching exercises using a wall, such as the so-called wall-stretching exercise for pectoralis muscles. The method is executed by placing both arms at a particular location on a wall to fix the insertion of the pectoralis muscles and moving the trunk (origin) toward the wall to lengthen the muscles.^{5,22,23}

Previously, wall exercises typically utilized a single position and primarily targeted the anterior muscles.²⁴ However, the shoulder muscles are attached at various points⁶, and changing the position of the hands during these exercises could potentially engage other muscles besides the anterior ones. Repetitive movements that are a part of daily life can lead to asymmetries in flexibility between both arms.²⁴ Examining both sides can determine whether there is an imbalance in shoulder flexibility. This information is valuable for modifying training routines to address these imbalances efficiently. Optimizing overall flexibility may involve focusing on balanced motions or applying additional stretching to the tighter side. Evaluating both arms provides a more comprehensive picture of the full range of shoulder motion, as measuring only the dominant hand might underestimate the need for improved flexibility, potentially overlooking limitations on

the non-dominant side.

To develop an easy, self-administering, and practical strategy to promote shoulder flexibility, the researchers proposed a modified wall-stretching exercise from that of a wall-stretching exercise for pectoral muscles. They investigated its immediate effects on shoulder flexibility. In addition, the study secondarily explored the proportion of arms (i.e., dominant and non-dominant arms) with limited shoulder flexibility. Most participants would have different shoulder flexibility between the dominant and non-dominant arms. The researchers believed that the findings would offer an alternative practical strategy that can be applied to promote shoulder flexibility easily in various routine settings.

Material and methods

Study design and participants

This quasi-experimental study was conducted in male and female adults aged 18 years old and over who had limited shoulder flexibility, at least one side, as measured using the back scratch test^{25,26} with a distance less than zero who did not have severe pain (i.e., a visual analog scale <5 out of 10).²⁷ Participants were excluded if they had general laxity and hypermobility of joints as determined using a hyperabduction test^{28,29} or any musculoskeletal or neuromusculoskeletal abnormalities that might interfere with the outcomes of the study, e.g., arthritis, cervical radiculopathy, impingement, fracture, frozen shoulder, and joint dislocation or subluxation.^{11,30} The sample size of this study was derived from a pilot study with a confidence level of 0.05 and power of 86% that recruited 54 participants. The research protocols followed the standards of the University Ethics Committee for Human Research. Eligible participants signed a written informed consent form before participating in this study.

Experimental protocols

Eligible participants were interviewed and assessed for their demographics (including age, body weight, height, and body mass index), musculoskeletal injury history, any form of exercise daily, and dominant and non-dominant arms as determined using the Edinburgh Handedness Inventory.^{31,32} Then, the participants were assessed for their shoulder flexibility using the back scratch test for both arms.^{25,26} Subsequently, they performed a modified wall-stretching exercise, with the repeated back scratch test thereafter. Details of the stretching exercise and testing protocols are as follows.

Stretching protocol: A modified wall-stretching exercise

This technique aims to stretch soft tissues around both shoulders with body-weight assistance. Participants stood facing a wall at arm-length from the wall and placed their hands against the wall at the shoulder levels with elbow and wrist extensions in three positions, including putting the hands upward, sideward, and downward (Figure 1). Participants were instructed to fix their hands on the wall in each hand position, move the upper trunk downward as far as they could without pain, and hold a

maximal stretching position for 15 seconds.^{18,33,34} Then, they repeated the exercise protocol with the other hand positions (Figure 1). Thus, the total stretching duration

was 45 seconds, with a 10-second rest period between the trials as required.



Figure 1. Modified wall-stretching protocols with the different arms placing.
A: starting position, B: position while stretching, C: upward hand position,
D: sideward hand position, E: downward hand position.

Outcome measure: The back scratch test

The study applied a back scratch test to assess soft tissue flexibility before and after the exercise protocols. The intra-rater reliability of the back scratch test, performed by a physiotherapist with seven years of experience, was found to be good (ICC=0.8), indicating high consistency in measurement similar to the previous study that reports It is reliable (ICCs: 0.98, 95 % CI: 0.98 to 0.97) and valid measure for upper limb and upper trunk flexibility.^{25,26} Participants

were in a standing position. Then they attempted to touch both hands behind the back, with one hand reaching over the shoulder and the other behind their back to reach upward as high as possible. The distance between the fingertips was measured. The scores were provided as zero if the fingertips of both hands touched each other and as a negative distance (in cm) if they did not touch (Figure 2). The average outcome over two trials was recorded.^{25,26}



Figure 2. A method of back scratch test (note: participant in this figure is right-handed).
A: measurement for the dominant arm, B: measurement for the non-dominant arm.

Statistical analysis

The Shapiro-Wilk test was used to assess the normality of the data distribution. Descriptive statistics were utilized to explain the demographics and findings of the study. The paired samples t-tests were applied with normal data distribution to analyze the changes before and after the stretching exercise. The independent t-test analyzed the data between dominant and non-dominant arms. The level of significance was set at $p < 0.05$.

Results

Fifty-six participants (38 females, 68%) with an average age of 42.5 ± 16.6 years (ranging from 18 to 75 years old), representing a young to middle-aged adult population, and a body mass index of 25.7 ± 4.8 kg/m², indicating a normal to overweight weight range, were involved in this

study. Most participants had sedentary lifestyles, and 10 participants (18%) had a history of shoulder injury due to strain, falls, and overuse. However, they did not have any obvious pain while moving the shoulders.

Most participants had problems with shoulder flexibility on both arms ($N=35$, 62.5%, Figure 3), while the rest had issues only with one shoulder ($N=21$, 37.5%). Thus, there were 91 shoulders with limited flexibility in this study, whereby most of the problems were found on the non-dominant arm (60.44%, Figure 3). The baseline flexibility of both shoulders, as measured using the back scratch test for both arms, was more significant than -10 cm (Table 1). Immediately after modified wall-stretching, participants significantly improved their flexibility by approximately 3cm ($p < 0.001$, Table 1).

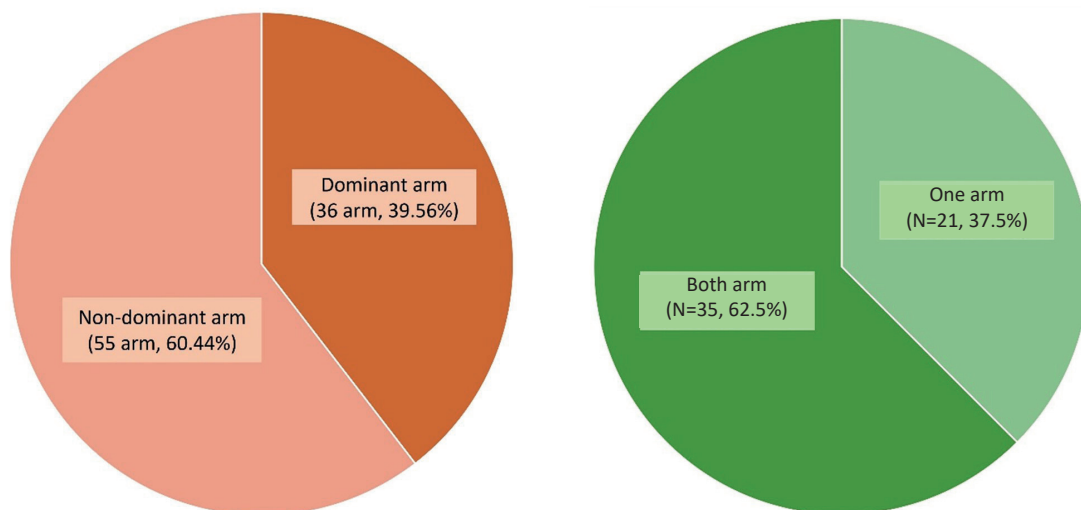


Figure 3. A proportion of participants with limited shoulder flexibility in this study.

Table 1. The change of shoulder flexibility following the modified wall-stretching exercises for the dominant and non-dominant arms.

Variable [‡]	Pre-test (cm)	Post-test (cm)	Mean difference (cm)	p value
Dominant arm (N=36)	-11.13±9.08 (-14.20: -8.06)	-8.02±8.97 (-11.06: -4.98)	-3.10±3.57 (-4.31: -1.89)	<0.001*
Non-dominant arm (N=55)	-13.17±8.26 (-15.40: -10.93)	-10.19±8.52 (-12.50: -7.89)	-2.97±2.95 (-3.77: -2.17)	<0.001*

Note: [‡]There were 91 arms with limited shoulder flexibility from a total of 56 participants.

The data is presented using mean±SD (95%CI) with the p value from the paired t-test, *indicates a significant difference between the pre-test and post-test, cm: centimeter, SD: standard deviation, CI: confidence interval.

Discussion

This study proposed an easy, self-administering, and practical method to improve shoulder flexibility using a modifying wall-stretching exercise and assessed its immediate effects. The findings indicated that participants had limited shoulder flexibility, particularly on the non-dominant arm, i.e., the non-dominant arm on the top and the dominant arm behind their back (Figure 2). After performing a modified wall-stretching exercise, participants immediately improved the outcomes of the back scratch test ($p < 0.001$, Table 1).

The higher proportion of limited shoulder flexibility on the non-dominant arm might be associated with current daily activities. Most participants (65%) had a sedentary lifestyle. They spent most of their time in flexion postures using social media on mobile phones or computers, which could reduce their muscle strength, especially on the non-dominant arm in an overhead activity.³⁵ Moreover, being in a slouching posture over a long time could decrease the flexibility of the anterior compartment of the trunk due to soft tissue tightness that limits the ability to move the arm behind the back.³⁶ Previous studies also found the

shoulder flexibility in the dominant arm exceeding that of the non-dominant arm due to daily use of the dominant limb, including self-grooming, dressing, eating, and lifting objects.²⁴

The modified wall-stretching exercise, a form of static stretching, requires participants to place their hands against a wall and move their upper trunk downward until reaching the position of maximal stretch (Figure 1). This protocol effectively stretches both ends of the soft tissues in the arms and upper trunk, aided by body weight, all within a pain-free range.^{23,37} Previous research has shown that static stretching improves the range of motion and is generally safer than other stretching methods.⁶ However, many methods lack stable surfaces and require expert supervision to ensure proper form. In contrast, using a wall and body weight for stretching provides a stable surface, maximizing the stretch's effectiveness.²⁰ By leveraging body weight, individuals can control the intensity of the stretch, allowing for deeper stretches without overexertion. Muscle spindles and Golgi tendon organs play a crucial role in wall stretching.³⁸ Muscle spindles detect changes in muscle length and initially cause the muscle to contract to prevent overstretching, while Golgi tendon organs sense tension and induce muscle relaxation, enabling deeper stretches.^{9,20,38} Adjusting hand positions—upward, sideward, and downward (Figure 1)—further enhances the stretch by targeting different muscle groups around the shoulders and arms. This helps counteract the effects of rounded shoulders and forward head posture, typical in individuals who spend long periods sitting or using devices. The back scratch test outcomes demonstrated a significant improvement immediately after the exercise ($p < 0.001$, Table 1), with an improvement of approximately 3 cm (Table 1), which is notably more remarkable than the minimum detectable change level of the test (1.41 cm).²⁵ These findings suggest that the modified wall-stretching exercise may offer clinical benefits for enhancing flexibility in the upper limbs and trunk.

Previously, Stanziano *et al.* employed a combination of five stretching positions (back scratch, back arm press, overhead back, overhead side, and cross chest) to target shoulder muscles in older adults aged over 80 years.³⁹ The 9 participants performed these exercises twice a week for eight weeks, actively pulling on a rope looped across the limb. The results showed significant improvements in shoulder flexibility, with gains ranging from 0.83 to 1.76 cm in the back scratch test.³⁹ Similarly, Choi and Sohng investigated the effects of a modified yoga program that included floor-seated exercises on shoulder flexibility in older adults with an average age of 77 years.⁴⁰ After a 12-week exercise regimen, participants improved flexibility in both the dominant and non-dominant shoulders by 2 to 3.29 cm.⁴⁰

In contrast, the present study involved a broader age range, with participants averaging 42.5 ± 16.6 years and ranging from 18 to 75 years. Despite the shorter duration of each exercise—only 15 seconds per position, with three positions and a single repetition—the study demonstrated a similar improvement in shoulder flexibility of approximately

3 cm. This suggests that even brief, focused stretching sessions can be practical across a wider age range. The simplicity and practicality of this method, which does not require specialized equipment or extended supervision, make it easily applicable in various settings. This alternative approach may be particularly beneficial for those with limited time or access to guided exercise programs

Limitations

The study was conducted as a quasi-experimental design without a control group or a follow-up period to assess the long-term effects of the exercise. Participants did not have common shoulder issues such as pain or frozen shoulder, which are often associated with limited flexibility. Future research should use randomized controlled trials involving participants with shoulder flexibility limitations and related conditions (e.g., shoulder pain and frozen shoulder), along with a follow-up period, to evaluate the sustained benefits of the exercise protocol. Additionally, future studies should classify participants by specific age groups or limit the age range to better understand age-specific responses to the modified wall-stretching exercise. This approach will help determine the optimal application of the exercise protocol across different age demographics

Conclusion

This study investigated the immediate effect of modified wall stretching on shoulder flexibility. The results demonstrated a significant improvement in shoulder flexibility immediately after the exercise, particularly addressing limitations in both arms. These findings suggest that the modified wall-stretching exercise offers a practical and accessible method to enhance shoulder flexibility and is suitable for self-administration in various settings.

Conflict of interest

The authors declare no conflict of interest.

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