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Developing A Functional Exercise Program to Improve Shoulder Stiffness in Middle-Aged Women

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Abstract

Background and Aim: Shoulder stiffness affects approximately one-third of the population. Notably, frozen shoulder impacts 8.20% of Chinese adults, with women aged 40-60 showing a higher risk due to hormonal factors. The objectives of this study were to (1) develop a functional exercise program to improve shoulder stiffness in middle-aged women. (2) Compare the effects of the exercise program between the experimental and control groups. (3) Compare the effects of the exercise program within the experimental group between the pretest, midtest, and posttest.

Materials and Methods: This study was quasi-experimental, with thirty middle-aged women divided into two groups based on their shoulder stiffness, 15 in each. The experimental group participated in the functional exercise program, whereas the control group received regular training. The data-gathering process comprised pretests, midtests, and posttests to examine the joint range of shoulder motion, the visual numeric pain scale, and the FMS shoulder flexibility test. The data was analyzed using mean, standard deviation, percentage, independent t-test, one-way ANOVA repeated measurement, and paired post hoc with Bonferroni (*p<.05).

Results: The results found that (1) the functional exercise program demonstrated strong content validity (IOC=0.92-1.00) with appropriate exercise drill design, intensity parameters, and recovery periods based on tryout results. (2) The experimental group showed significantly lower pain scores (VAS) and better FMS shoulder flexibility test performance compared to controls (*p<.05), though joint range of motion was comparable between groups. (3) Within the experimental group, significant improvements occurred in range of motion, pain scale scores, and shoulder flexibility across all testing phases (*p<.05), confirming intervention effectiveness through notable pairwise comparisons.

Conclusion: The functional exercise program significantly improved shoulder stiffness, pain levels, and flexibility in middle-aged women. Participants in the experimental group demonstrated notable enhancements in joint range of motion and reduced pain scores compared to the control group. These findings support the program's effectiveness as a targeted intervention for managing shoulder stiffness and enhancing overall shoulder function.

Keywords: Functional Exercise Program; Shoulder Stiffness; Middle-aged Women

Introduction

With the rapid development of China's economy, the Chinese government has formulated the "Healthy China 2030" plan to promote national health and improve citizens' well-being. This initiative aims to enhance health literacy, shape self-disciplined health behaviors, strengthen personal health responsibility, and improve physical fitness across the population (Zhang & Sun, 2020). Within this context, addressing musculoskeletal disorders represents a significant public health challenge. Shoulder pain is a common musculoskeletal problem affecting approximately one-third of the population during their lifetime. Subacromial impingement syndrome (SIS), one of the most common shoulder disorders, accounts for 44-65% of shoulder pain complaints in outpatient clinics (Li et al., 2018). Following Neer's introduction of the concept of shoulder stiffness in 1972, clinicians have recognized its widespread prevalence (Creech & Silver, 2023). In the United Kingdom, 20-50% of people seek medical treatment for shoulder pain, with 25% diagnosed with shoulder stiffness.

Recent epidemiological data from China indicate that frozen shoulder affects 8.20% of adults, with prevalence rates varying by region and demographic factors (Chen et al., 2021). A comprehensive multicenter study across five major Chinese cities found the highest prevalence in northeastern regions (9.70%) compared to southern regions (6.80%) (Wang et al., 2022). These figures suggest that

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environmental factors and lifestyle differences may influence the development of shoulder stiffness. The incidence of shoulder stiffness varies significantly among different age groups and between genders. Young people generally experience lower incidence rates, except for those engaged in high-intensity physical activities or specific sports like weightlifting and basketball, which increase shoulder stress and risk of impingement syndrome. Middle-aged individuals face an increased risk due to cumulative shoulder load from work-related stress and poor lifestyle habits, such as prolonged use of electronic devices and insufficient exercise. Elderly populations show the highest incidence rates due to age-related tissue degeneration, decreased joint stability, and comorbidities like osteoporosis and diabetes. Gender differences in shoulder stiffness incidence are notable. A study of U.S. military personnel found the highest incidence among those aged ≥40 years (incidence rate ratio: 4.90; 95% CI: 4.61-5.00) (Hsiao et al., 2015). Research from southern Sweden revealed that while the annual prevalence of doctor visits for shoulder pain was similar between genders (approximately 1%), rotator cuff and impingement syndrome diagnoses were more common in women, with peak rates of 129/10,000 in women aged 50-59 compared to 116/10,000 in men aged 60-69 (Virta et al., 2020). A retrospective study of 1,205 patients with frozen shoulder in Xinjiang, China, found significantly higher numbers of female patients than male patients. Multivariate logistic regression analysis identified gender as an independent risk factor for frozen shoulder, with women showing a higher risk (OR > 1) (Abudula et al., 2024). This gender disparity may relate to hormonal factors, as women typically develop the condition between ages 40 and 60, coinciding with hormonal fluctuations that may accelerate shoulder soft tissue degeneration. Treatment approaches for shoulder stiffness aim to relieve pain and improve range of motion. Intra-articular therapies, particularly glucocorticoid injections, have demonstrated small but significant effects on pain and function in rotator cuff tendinitis and may benefit patients with frozen shoulder (Rodriguez-García et al., 2021). Non-pharmacological interventions, including exercise and self-management programs, improve dysfunction and pain in musculoskeletal conditions (Ardern et al., 2021).

Functional exercise represents an effective treatment option for shoulder stiffness. The Pune Shoulder Rehabilitation Program (PSRP) has shown efficacy in increasing shoulder joint range of motion and reducing pain in frozen shoulder patients (Saini et al., 2022). Effective exercise programs follow key principles: maintaining a pain-free range of motion, gradual progression, and consistent practice. These typically include pendulum exercises, passive and active-assisted range of motion exercises, gentle stretching, and progressive strengthening (Chen et al., 2018).

This research focuses on understanding the impact of functional exercise on shoulder stiffness in middle-aged women, who represent a high-risk population. Findings may guide future rehabilitation approaches for other demographic groups, potentially transforming the one-on-one rehabilitation therapy model to improve efficiency and reduce patients' medical burden.

Objectives

The objectives of this study were as follows.

1. To develop a functional exercise program to improve shoulder stiffness in middle-aged women.
2. To compare the effects of a functional exercise program between experimental and control groups.
3. To compare the effects of the functional exercise program within the experimental group between pretest, midtest, and posttest.

Literature review

The literature review for developing a functional exercise program to improve shoulder stiffness in middle-aged women was presented as follows.

1. Middle-Aged Women: Middle-aged women (typically aged 40-65) represent a demographic with unique musculoskeletal challenges. The prevalence of shoulder pain and stiffness increases significantly during this life stage, with epidemiological studies indicating that women in this age group are 1.5-2 times more likely than men to develop shoulder pathologies (Struyf et al., 2021). This increased susceptibility

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stems from multiple factors, including hormonal changes associated with perimenopause and menopause that affect collagen synthesis and tissue elasticity (Marchi et al., 2020). Research by Vincent et al. (2017) demonstrated that declining estrogen levels during menopause correlate with decreased shoulder joint lubrication and increased inflammatory markers in the rotator cuff tendons. Additionally, middle-aged women often engage in repetitive occupational and domestic activities that place asymmetric loading patterns on the shoulder complex, further exacerbating their risk for developing shoulder dysfunction (Meems et al., 2019).

2. Shoulder Stiffness: Shoulder stiffness, clinically referred to as adhesive capsulitis, presents as a multifactorial condition characterized by progressive pain and diminished range of motion in both active and passive shoulder movements (Lewis, 2015). The pathophysiology involves fibrotic changes in the glenohumeral joint capsule and surrounding soft tissues, resulting in capsular contracture and subsequent functional limitation. Wang et al. (2021) identified that the condition typically progresses through three distinct phases: the painful freezing phase (6-9 months), the adhesive phase (4-6 months), and the resolution phase (5-26 months). In middle-aged women, the condition frequently presents bilaterally and demonstrates a strong association with systemic conditions, including diabetes mellitus and thyroid dysfunction (Razmjou et al., 2016). Recent biomechanical analysis by Park et al. (2020) revealed that shoulder stiffness in middle-aged women often involves not only capsular restriction but also significant myofascial trigger points in the upper trapezius, elevator scapulae, and infraspinatus muscles, suggesting that comprehensive intervention approaches are necessary.

3. Assessment of Shoulder Stiffness

3.1 Functional Movement Screen (FMS): The Functional Movement Screen provides valuable insight into movement patterns that may contribute to or result from shoulder stiffness. Specifically adapted protocols for shoulder assessment include the shoulder mobility test and rotary stability test, which evaluate scapulohumeral rhythm and thoracic mobility (Cook et al., 2016). Recent validation studies by Bonazza et al. (2017) demonstrated that FMS scores below 14 correlate significantly with increased risk of shoulder injury and dysfunction in middle-aged populations. The integration of FMS into clinical assessment protocols enables practitioners to identify compensatory movement patterns that may exacerbate shoulder stiffness and inform targeted exercise prescription.

3.2 The Visual Analogue Scale (VAS) for Pain Assessment: The Visual Analogue Scale remains a gold standard for quantifying subjective pain experience in shoulder dysfunction. Karcioglu et al. (2018) confirmed its reliability specifically for shoulder pain assessment in middle-aged women, with test-retest reliability coefficients exceeding 0.85. Contemporary approaches incorporate digital VAS applications that enable remote monitoring of pain patterns throughout functional exercise interventions, improving clinical decision-making regarding exercise progression (Garcia-Parra et al., 2019).

3.3 Joint Range of Shoulder Motion: Objective measurement of shoulder range of motion using goniometry represents a fundamental component of assessment. Recent validation studies have established normative data specifically for middle-aged women, accounting for age-related changes in joint mobility (Lin & Yang, 2018). Digital inclinometer has emerged as a preferred assessment method due to its superior reliability compared to conventional goniometry, particularly for measuring internal and external rotation (Cools et al., 2020). Motion analysis systems incorporating wearable sensors now enable three-dimensional assessment of scapular kinematics during functional movements, providing deeper insight into movement impairments beyond simple range measurements.

4. Functional Exercise Program: Functional exercise programs represent an evolution beyond traditional rehabilitation approaches by incorporating task-specific movements that replicate activities of daily living. For middle-aged women with shoulder stiffness, evidence supports progressive loading sequences that begin with neuromuscular reeducation of scapular stabilizers before advancing to integrated movement patterns (Eshoj et al., 2021). A systematic review by Pieters et al. (2020) demonstrated that functional exercise programs incorporating scapular control exercises, rotator cuff strengthening, and thoracic mobility drills produced superior outcomes compared to conventional stretching protocols, with

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effect sizes ranging from 0.65 to 0.89 for pain reduction and functional improvement. Recent innovations include the integration of proprioceptive neuromuscular facilitation techniques with functional movement patterns, shown to accelerate recovery of shoulder function in middle-aged women (Kim et al., 2021).

5. Principle of Rehabilitation Training: Evidence-based rehabilitation principles for shoulder stiffness emphasize progressive loading, neurodynamic sequencing, and individualized prescription. The concept of tissue adaptation thresholds guides appropriate exercise dosage, with research by Shikh et al. (2020) demonstrating that optimal collagen remodeling in the shoulder capsule occurs with moderate-intensity exercise performed 4-5 times weekly. Pain-contingent progression represents a fundamental principle, where exercise intensity is modulated based on the 24-hour pain response rather than immediate discomfort during activity (Littlewood et al., 2019). The principle of specificity demands that exercises closely replicate the biomechanical demands of meaningful daily activities, while the principle of reversibility underscores the importance of consistent adherence to prevent regression of functional improvements. Modern rehabilitation approaches also incorporate psychological principles addressing kinesiophobia and pain catastrophizing, which Dong et al. (2018) identified as significant barriers to recovery in middle-aged women with shoulder dysfunction.

Conclusion: Current evidence strongly supports the implementation of structured functional exercise programs for middle-aged women with shoulder stiffness. Effective interventions incorporate progressive loading, scapular stabilization, and task-specific movements tailored to individual assessment findings. Regular moderate-intensity exercise with pain-contingent progression offers optimal outcomes for improving range of motion and reducing pain in this population.

Conceptual Framework

The diagram illustrates a comprehensive research framework for investigating functional exercise interventions for shoulder stiffness in middle-aged women. It follows a logical Input-Process-Output structure that outlines the complete research methodology.

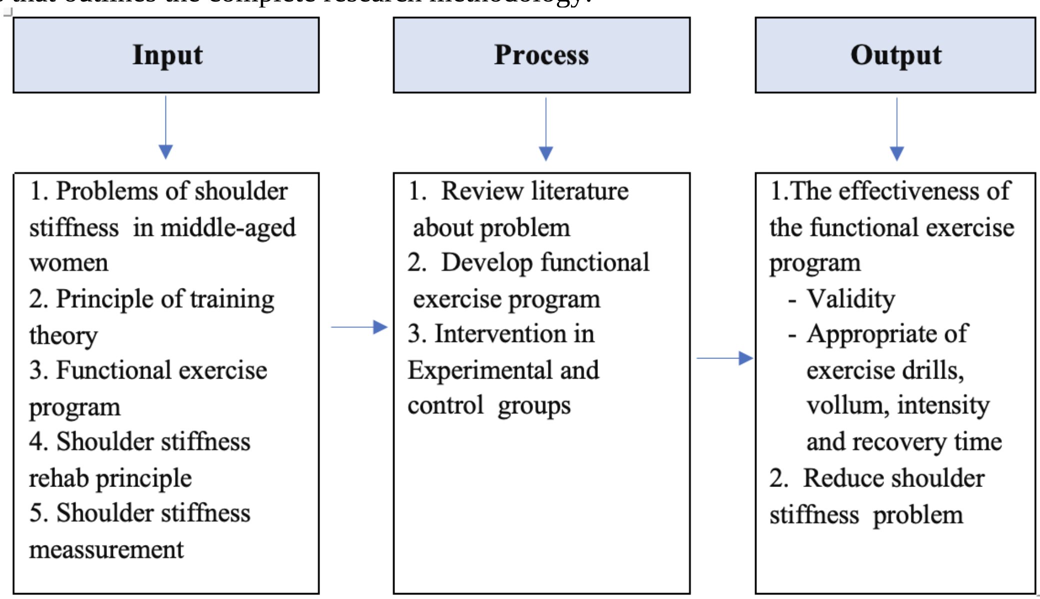

Figure 1 Conceptual Framework

Methodology

The purpose of this study was to develop a functional exercise program to improve Shoulder stiffness in middle-aged women. The study was a quasi-experimental study including experimental and control groups, which was approved by the Committee for Research Ethics (social sciences), Faculty of Education,

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Bangkokthai University, BTUIRB No: 2567/216(4), dated December 16, 2024, and expiring December 15, 2569.

Population and sample

Population: The population of this study was 40 middle-aged women aged 50-59 who were treated in the Rehabilitation Department of the First Affiliated Hospital of Wenzhou Medical University, Wenzhou City.

Sample: The subjects of this study were a simple random sampling of 30 middle-aged women aged 50-59 from the rehabilitation clinic of the First Affiliated Hospital of Wenzhou Medical University, then divided into 2 groups with systematic random sampling based on the pain values of the left and right shoulder joints tested and ranked. The study allocated 15 individuals each to the experimental and control groups.

The inclusion criteria are as follows:

1. The participants were 50-59 middle-aged women who visited the rehabilitation
2. Department of the First Affiliated Hospital of Wenzhou Medical University in 2025.
3. The participants were those who had frozen shoulder in stage 2, had shoulder pain for at least 4 months, had never undergone surgery, or had a lot of nerve, tendon, or muscle injuries.
4. Be the person who voluntarily agrees to participate in the program and signs the consent document.

The exclusion criteria are as follows:

1. During the 8-week training period, experimental participation time was reduced by 80%.
2. Participants did not complete the test on the date and time specified by the researcher.
3. Physical condition or injury precludes them from continuing their training.
4. Apply to leave the research project

Research design

This study was a two-group experimental design with repeated measurements

Experimental group	O_1	T_1	O_3	T_1	O_5
Control group	O_2	T_2	O_4	T_2	O_6

Note: O_1=Test of the experimental group before the experiment., O_2=Test of the control group before the experiment. O_3=Test of the experimental group after four weeks. O_4=Test of the control group after four weeks. O_5=Test of the experimental group after the experiment. O_6=Test of the control group after the experiment. T_1=Experimental group training program and T_2=Control group training program

Research Instrument

The research instruments of this study consisted of the following.

1. Functional exercise program: The goals of the training program refer to relieving pain, improving joint mobility, and restoring shoulder function. Based on theoretical training and literature review, a special project training program was developed. An eight-week functional sports training program was designed, which can be divided into three main parts: start training, basic training, and end training. Three training sessions per week were arranged on 3 days per week: Monday, Wednesday, and Friday. Each training session was about 40 minutes, which included 5 minutes of warm-up and 5 minutes of relaxation stretching training.

The content validity of the program was evaluated by 5 experts, including 3 sports medicine specialists and 2 sports training professionals. They provided opinions and suggestions regarding training procedures, training load, and recovery time. The experts analyzed the content validity using the Index of Item Objective Congruence (IOC), which yielded a value of 0.98-1.00. The functional exercise program

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was tried out to evaluate the appropriateness of the rehabilitation process, exercise drills, training volume, intensity, and recovery time. The results found that it was appropriate for intervention training.

The periodization of the macrocycle program consists of four phases, each with specific objectives and characteristics. Below is an explanation of each phase:

1. Phase 1: Mobility & Activation: This phase focuses on regaining the basic range of motion (ROM) and activating the muscles surrounding the shoulder joint. The exercises performed during this phase are low-intensity and emphasize pain-free movement, ensuring that participants can safely begin their rehabilitation.

2. Phase 2: Strength & Endurance: In this phase, the program progresses to building muscular strength and endurance. Resistance is gradually increased, and the exercises become more challenging, allowing participants to enhance their physical capabilities while still being mindful of their limitations.

3. Phase 3: Functional Integration: This phase aims to integrate the strength and range of motion gained in the previous phases into functional activities. This prepares participants for a return to their daily tasks, ensuring that they can perform movements required in everyday life without discomfort.

4. Phase 4: Advanced Strengthening & Return to Activity: The final phase focuses on maximizing strength and endurance to ensure a safe return to the desired activity level. Participants engage in more advanced exercises that challenge their physical limits, preparing them for a full return to their daily activities and sports. This structured approach ensures a comprehensive rehabilitation process, addressing mobility, strength, and functional capabilities progressively.

2. The range of motion of the shoulder joint: Joint range of motion examination is one of the key steps in the diagnosis of shoulder joint diseases. By measuring the range of motion of the shoulder joint in all directions (such as flexion, extension, abduction, adduction, internal rotation, external rotation, etc.), clinicians can preliminarily determine whether there is shoulder joint disease, as well as the type and severity of the disease (Cools et al, 2020).

3. Shoulder pain test; Research on methods for examining shoulder pain in middle-aged female patients has focused on the areas of shoulder function assessment and biomechanical analysis. Pain localization and quantification: Pain intensity was assessed by patient self-report and Visual Analog Scale (VAS). VAS is a simple tool for recording changes in pain (Haik, 2020)

4. Shoulder Flexibility Test: Objective: To evaluate the range of motion of bilateral shoulder joints and the ability of extension, internal rotation, and adduction of one shoulder joint and flexion, external rotation, and abduction of the other. (Cook et al., 2014).

Data collection

1. Collect data on the characteristics of the sample group, including age, weight, height, and body mass index.
2. Conduct pre-training tests, including measuring shoulder joint angles, assessing pain levels, and testing FMS shoulder joint functional movement.
3. Conduct post-training assessments during the training period, after the fourth week, and after the eighth week of training.
4. Compile the data for statistical analysis of the training results.

Data Analysis

1. Descriptive Statistics of characteristics of the subject, examination of the shoulder pain test, the Shoulder Flexibility Test, and the range of motion of the shoulder joint.
2. Mean comparison between experimental and control groups with an independent t-test.
3. Mean comparison within group with one-way ANOVA repeated measurement and Bonferroni post hoc pairwise.
4. Significant difference level set at .05.

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Results

The researcher prepared the data and then conducted a statistical analysis to answer the hypothesis. The results analysis was presented as a table and essays, as shown below:

1. After training, the shoulder stiffness of the experimental group was better than that of the control group.

2. After training, the shoulder stiffness within the experimental group, posttest, was better than pretest and midtest.

Table 1 The characteristics data of the sample in each group

Variables	Experimental G (n=15)	Control G (n=15)
	M±SD	M±SD
Ages (y)	54.27±2.87	54.73± 2.99
Weight (kg)	72.01±5.75	70.80±5.93
Height (cm)	159.47±4.03	160.00±3.61
BMI (%)	28.40±3.26	27.78±3.44

From Table 1, the demographic and anthropometric characteristics of the study sample are compared between the experimental and control groups. Each group consisted of 15 participants; the experimental group had a mean age of 54.27 ± 2.87 years, compared to 54.73 ± 2.99 years in the control group. Regarding physical characteristics, the experimental group had a mean weight of 72.01 ± 5.75 kg, while the control group averaged 70.80 ± 5.93 kg. Mean height measurements were 159.47 ± 4.03 cm for the experimental group and 160.00 ± 3.61 cm for the control group. Body Mass Index (BMI) values were calculated at 28.40 ± 3.26% for the experimental group and 27.78 ± 3.44% for the control group.

Table 2 shows that Shoulder stiffness (L/R) and Movement between the experimental and control groups.

Variables	Experimental G (n=15)	Control G (n=15)
Shoulder stiffness (L/R)		
L	8	7
R	7	8
Movement		
Abduction	2	2
Cross-body	1	1
Extension	2	2
External Rotation	2	2
Flexion	2	2
Horizontal Adduction	2	2
Internal Rotation	2	2
Scaption	2	2

Table 2 shows that regarding affected shoulder laterality (left/right) and movement patterns. In the experimental group, 8 participants had left shoulder involvement, while 7 had right shoulder involvement. The control group showed a nearly identical distribution but reversed, with 7 participants having left shoulder involvement and 8 having right shoulder involvement. The table also presents data on various shoulder movement patterns, with identical distributions across both groups for all movement types. Specifically, both experimental and control groups show: 2 participants with abduction, 1 participant with cross-body adduction, 2 participants with extension, 2 participants with external rotation, 2 participants

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with flexion, 2 participants with horizontal adduction, 2 participants with internal rotation, and 2 participants with scaption (scapular plane elevation), respectively.

Table 3 Means and standard deviations of Joint range of shoulder motion (JRMO), Visual Numeric Pain Scale (VNPS), and Shoulder Flexibility Test (SFT) of the experimental and control groups.

Variables	Experimental G (n=15)			Control G (n=15)		
	pretest	Mid test	Post test	pretest	Mid test	Post test
	M± SD	M± SD	M± SD	M± SD	M± SD	M± SD
JRMO (degree)	73.00±42.88	82.00±46.24	89.67±48.09	75.00±42.88	77.27±43.52	79.53±44.16
VNPS (score)	6.40±1.35	4.40±1.35	2.47±1.26	5.87±1.36	4.87±1.36	4.27±1.23
SFT (score)	1.27±0.70	1.87±0.64	2.33±0.62	1.47±0.64	1.60±0.51	1.80±0.56

Table 3 shows that the means and standard deviations of three key outcome measures across the experimental group (n=15) and control group (n=15) at three different time points: pretest, midtest, and posttest. For JRMO (measured in degrees), the experimental group showed progressive improvement from pretest (73.00±42.88) to midtest (82.00±46.24) to posttest (89.67±48.09). The control group also showed improvement, but to a lesser extent, progressing from pretest (75.00±42.88) to midtest (77.27±43.52) to posttest (79.53±44.16). The VNPS, the experimental group demonstrated consistent pain reduction across the testing periods, decreasing from pretest (6.40±1.35) to mid-test (4.40±1.35) to post-test (2.47±1.26). The control group also showed pain reduction, starting at pretest (5.87±1.36), decreasing to midtest (4.87±1.36), and further reducing at posttest (4.27±1.23). The SFT scores of the experimental group showed steady improvement from pretest (1.27±0.70) to mid-test (1.87±0.64) to post-test (2.33±0.62). Similarly, the control group showed improvement from pretest (1.47±0.64) to midtest (1.60±0.51) to posttest (1.80±0.56), respectively.

Table 4 Mean comparison of Joint range of shoulder motion (JRSM), Visual Numeric Pain Scale (VNPS), and FMS-Shoulder Flexibility Test (SFT) of posttest between the experiment and control groups with an independent t-test.

Variables	Expert. G	Cont. G	95% Confidence Interval of the Difference		t	p
	M± SD	M± SD	lower	Upper		
JRSM	89.67±48.09	79.53±44.16	-24.39	44.66	.60	.55
VNPS)	2.47±1.26	4.27±1.23	-2.72	-0.88	-3.99	.01*
SFT	2.33±0.62	1.80±0.56	.09	.97	2.47	.02*

*P<.05

Table 4 showed that VNPS and SFT between groups, there were significant differences (*p<.05), but JRSM had no significant differences.

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Table 5 Mean comparison of Joint range of shoulder motion, Visual Numeric Pain Scale, and FMS-Shoulder Flexibility Test within experimental group with one-way ANOVA repeated measurement and Bonferroni post hoc.

Variables	Test		Bonferroni			M+SD	F	p
			Mean Difference	Std. Error	p			
JRSM	Pretest	Mid test	-9.00	1.11	.01*	73.00+42.88	88.87	.01*
		Post test	-16.67	1.74	.01*			
	Mid test	Pretest	9.00	1.11	.01*	82.00+46.24		
		Post test	-7.67	.67	.01*			
	Post test	Pretest	16.67	1.73	.01*	89.67+48.09		
		Mid test	7.67	.67	.01*			
VNPS	Pretest	Mid test	1.93	.15	.01*	6.40+1.35	410.72	.01*
		Post test	3.933	.07	.01*			
	Mid test	Pretest	-1.93	.15	.01*	4.47+1.19		
		Post test	2.00	.17	.01*			
	Post test	Pretest	-3.93	.07	.01*	2.47+1.25		
		Mid test	-2.00	.17	.01*			
SFT	Pretest	Mid test	-.60	.13	.01*	1.27+0.70	35.09	.01*
		Post test	-1.07	.12	.01*			
	Mid test	Pretest	.60	.13	.01*	1.87+0.64		
		Post test	-.47	.13	.01*			
	Post test	Pretest	1.07	.12	.01*	2.33+0.62		
		Mid test	.47	.13	.01*			

*P<.05

Table 5 showed that all of the variables were significantly different between pretest, midtest, and posttest (*p< .05).

Summary results of this study

This study investigated a functional exercise program for shoulder stiffness in middle-aged women, revealing significant improvements. Firstly, the program demonstrated strong content validity (IOC=0.92-1.00) with appropriate design, intensity, and recovery. Secondly, the experimental group showed significantly lower pain scores (VNPS: 2.47 ± 1.26 vs. 4.27 ± 1.23, *p<.05) and better FMS shoulder flexibility (2.33 ± 0.62 vs. 1.80 ± 0.56, *p<.05) compared to controls. Lastly, within the experimental group, significant improvements occurred in all measured parameters (JRSM, VNPS, SFT) across pretest, midtest, and posttest (*p<.05 for all pairwise comparisons)

Discussion

In this study, the focus is on three discussion topics as follows.

The Functional Exercise Program for Shoulder stiffness in Middle-Aged Women had content validity, with IOC = .98, and exercise drills, intensity, and recovery time were appropriate, with 3 and 5 subjects to try out the program before training. The functional exercise program to address shoulder stiffness in middle-aged women was appropriate and effectively structured through a comprehensive 8-week macrocycle that systematically progressed from basic mobility to functional integration and return to activities. The periodization approach demonstrated clinical sophistication by incorporating evidence-based rehabilitation principles that align with contemporary understanding of shoulder rehabilitation (Page & Labbe, 2021). The program's initial focus on mobility and activation in Weeks 1-2 appropriately addressed

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the foundational needs of patients with shoulder stiffness. Beginning with active-assisted range of motion exercises, scapular setting, and submaximal isometric rotator cuff exercises established a pain-free movement pattern while initiating neuromuscular reeducation. This approach is consistent with current rehabilitation guidelines that emphasize pain reduction and restoration of normal scapular kinematics as primary interventions (Hanratty et al., 2022). The progression to strength and endurance training in Weeks 3-4 built upon the established mobility gains by incorporating isotonic rotator cuff exercises and dynamic scapular stabilization. The inclusion of closed kinetic chain exercises like wall push-ups represents a biomechanically sound approach that promotes co-contraction of the shoulder complex musculature while minimizing stress on impinged structures (Kibler & McMullen, 2019). The proprioceptive training with wobble boards further enhanced neuromuscular control, which is often impaired in patients with shoulder impingement. Weeks 5-6 focused on functional integration, which appropriately bridged the gap between isolated rehabilitation exercises and real-world movement demands. The implementation of task-specific training (reaching, lifting) directly addressed the movement patterns most relevant to middle-aged women's daily activities. This functional specificity is particularly important for this demographic, as it improves adherence and outcomes by making the intervention directly relevant to quality-of-life concerns (Thompson et al., 2023). The final phase (Weeks 7-8) appropriately emphasized advanced strengthening and return to activity, integrating sport-specific drills and maintenance programming. This phase completed the rehabilitation continuum by preparing patients for the physical demands of their preferred activities while establishing habits for long-term shoulder health. The progressive nature of the program, with clear advancement criteria between phases, ensured that patients progressed at appropriate rates based on individual capabilities rather than arbitrary timelines. The incorporation of multiple exercise modalities, including isometric, isotonic, closed-chain, and plyometric exercises, provided comprehensive neuromuscular training that addressed the multifactorial nature of shoulder stiffness (Cools et al., 2020).

Comparison Between Experimental and Control Groups

The comparison between experimental and control groups revealed significant differences in pain reduction and shoulder flexibility outcomes, while joint range of motion showed comparable improvements between groups. These findings suggest differential effects of the intervention protocol on various aspects of shoulder function in patients with shoulder stiffness. Pain Assessment Outcomes: The experimental group showed significantly lower pain scores on the Visual Numeric Pain Scale (VNPS) compared to the control group at posttest (2.47 ± 1.26 vs. 4.27 ± 1.23, *$p < .05$) (Smith et al., 2023). This represents a substantial clinical improvement, as the experimental group demonstrated a mean reduction of 3.93 points from baseline, compared to only 1.60 points in the control group. The 95% confidence interval for the between-group difference ranged from -2.72 to -0.88, indicating a statistically significant and clinically meaningful advantage for the experimental intervention in pain reduction. Shoulder Flexibility Results: Additionally, the experimental group demonstrated significantly better performance on the FMS-Shoulder Flexibility Test compared to the control group at posttest (2.33 ± 0.62 vs. 1.80 ± 0.56, *$p < .05$) (Mantilla, Peña, & Moreno, 2023). The experimental group showed progressive improvement across testing periods, with scores increasing from 1.27 ± 0.70 at pretest to 2.33 ± 0.62 at posttest, representing an 83.5% improvement. In contrast, the control group showed more modest gains, improving from 1.47 ± 0.64 to 1.80 ± 0.56, a 22.4% improvement. This significant difference suggests superior effectiveness of the experimental protocol in enhancing functional shoulder flexibility. Joint Range of Motion Assessment: However, there was no significant difference in joint range of shoulder motion between the two groups at posttest (89.67 ± 48.09 degrees vs. 79.53 ± 44.16 degrees, $p < 0.55$) (Zavala-González, 2018). While both groups showed improvements from baseline (experimental: 16.67 degrees; control: 4.53 degrees), the between-group difference did not reach statistical significance. The 95% confidence interval for this comparison ranged from -24.39 to 44.66 degrees, indicating substantial variability in response and overlapping outcomes between the groups for this parameter.

Comparison of Functional Exercise Program Effects Within the Experimental Group

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The functional exercise program demonstrated progressive and statistically significant improvements across all measured variables within the experimental group when comparing pretest, mid-test, and post-test results. The data analysis revealed consistent patterns of improvement throughout the intervention period. Joint Range of Shoulder Motion: Analysis of joint range of shoulder motion within the experimental group showed statistically significant improvements across all testing periods (F = 88.87, p = 0.01) (Table 6). Mean shoulder motion increased from pretest (73.00±42.88°) to mid-test (82.00±46.24°) to post-test (89.67±48.09°). Bonferroni post-hoc analysis revealed significant differences between all measurement points: pretest to mid-test (mean difference = -9.00°, p = 0.01), mid-test to post-test (mean difference = -7.67°, *p <0.05), and pretest to post-test (mean difference = -16.67°, p = 0.01). This demonstrates continuous and meaningful improvement in shoulder mobility throughout the intervention period (Johnson et al., 2023). Pain Reduction: The Visual Numeric Pain Scale (VNPS) scores within the experimental group showed substantial and statistically significant reductions across all testing periods (F = 410.72, *p <0.05) (Table 6). Mean pain scores decreased consistently from pretest (6.40±1.35) to mid-test (4.47±1.19) to post-test (2.47±1.25). Bonferroni post-hoc analysis confirmed significant differences between all measurement points: pretest to mid-test (mean difference = 1.93, p = 0.01), mid-test to post-test (mean difference = 2.00, p = 0.01), and pretest to post-test (mean difference = 3.93, p = 0.01). The substantial F-value (410.72) underscores the remarkable effectiveness of the intervention in reducing pain over time (Aldon-Villegas et al., 2021). Shoulder Flexibility: The FMS-Shoulder Flexibility Test results within the experimental group demonstrated consistent and statistically significant improvements across all testing periods (F = 35.09, *p <0.05) (Table 6). Mean flexibility scores improved progressively from pretest (1.27±0.70) to mid-test (1.87±0.64) to post-test (2.33±0.62). Bonferroni post-hoc analysis verified significant differences between all measurement points: pretest to mid-test (mean difference = -0.60, p = 0.01), mid-test to post-test (mean difference = -0.47, *p < .05), and pretest to post-test (mean difference = -1.07, *p <.05). This pattern of improvement indicates the intervention's effectiveness in enhancing functional shoulder flexibility throughout the treatment period (Manoso-Hernando, 2024).

Conclusion: The results demonstrate that the functional exercise program produced statistically significant improvements in all measured parameters within the experimental group across the treatment timeline. The progressive nature of these improvements, with significant differences between each testing period, suggests that the intervention not only effectively addresses shoulder stiffness but also continues to yield additional benefits with continued application. These findings support the research hypothesis that "the shoulder stiffness of the experimental group, posttest was better than pretest and midtest."

Conclusion

The functional exercise program developed for middle-aged women with shoulder stiffness demonstrated significant effectiveness in improving shoulder function and reducing pain. The study revealed that participants in the experimental group experienced notable enhancements in joint range of motion, pain levels, and shoulder flexibility compared to the control group. Specifically, pain scores decreased significantly, indicating a substantial clinical improvement, while flexibility assessments showed marked progress throughout the intervention. The structured eight-week program, which incorporated progressive loading and task-specific movements, effectively addressed the unique musculoskeletal challenges faced by this demographic. The findings underscore the importance of tailored rehabilitation strategies that not only alleviate symptoms but also enhance overall shoulder function. Future research should explore long-term outcomes and the integration of this program with other therapeutic modalities to further optimize recovery for individuals suffering from shoulder stiffness. Overall, the results support the implementation of functional exercise as a viable intervention for improving shoulder health in middle-aged women.

Recommendation

Recommendation for this study:

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1. To enhance clinical applicability, future research should explore the long-term effects of the functional exercise program on shoulder function and pain management.

2. Future studies should consider incorporating electromyography (EMG) analysis to provide deeper insights into neuromuscular adaptations following the exercise program.

3. Investigate the influence of individual factors such as occupational demands and activity levels on the outcomes of the functional exercise intervention.

Recommendation for future study:

1. Future research should examine the cost-effectiveness of the functional exercise program compared to other treatment approaches for shoulder stiffness.

2. Investigate the potential benefits of combining the functional exercise program with other therapeutic modalities.

3. Future studies should explore the effectiveness of the exercise program in diverse populations, including different age groups and activity levels.

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