湖南大学学报（自然科学版）
Journal of Hunan University (Natural Sciences)

第 50 卷 第 9 期
2023 年 9 月

Available online at http://jonuns.com/index.php/journal/index

Vol. 50 No. 9
September 2023

Open Access Article

https://doi.org/10.55463/issn.1674-2974.50.9.1

Effect of 8-Week Slide Board Training Program on Shoulder Joint Pain and Function and Quality of Life of Male Swimmers with Shoulder Impingement Syndrome

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Received: June 25, 2023 / Revised: July 23, 2023 / Accepted: August 21, 2023 / Published: September 29, 2023

Abstract: Among sports injuries, due to the involved organs and specific patterns of different sports, shoulder joint injuries are frequently observed. Studies have reported chronic and acute shoulder pain symptoms in 30%–40% of athletes. Among all shoulder injuries, shoulder impingement syndrome is the most common cause of pain and limitation of the function of the shoulder area. This study aimed to investigate the effect of 8 weeks of slide board training on pain, shoulder joint function, and quality of life in male swimmers with shoulder impingement syndrome. The subjects of this research included 30 swimmers with shoulder impingement syndrome selected in an accessible and purposeful manner, divided into two groups of slide board exercises (15 people) and a control group (15 people) to evaluate the subjects' performance from the close kinetic chain upper extremity stability test, the pain level from the visual the analog scale questionnaire, the quality of life from the SF-36 quality of life questionnaire, and the balance from the Y balance test. Muscle strength measure used a muscular dynamometer, and shoulder joint range of motion measure used a goniometer. Repeated measures ANOVA test analyzed the data at a significance level of $p<0.05$. The results showed that slide board exercises had a significant effect on pain, functional stability of the shoulder joint, upper limb function, muscle strength, shoulder range of motion, and quality of life ($p\geq0.05$), but no significant difference was in the control group in the pre-test and post-test ($p>0.05$). Considering the positive effect of slide board exercises on pain, stability of shoulder joint function, upper limb balance, muscle strength, range of motion of the shoulder, and quality of life, the authors propose using these exercises in the rehabilitation stages of patients with shoulder impingement syndrome.

Keywords: shoulder impingement syndrome, shoulder joint function, quality of life, swimmers, slide board training.

8 週滑板訓練計畫對肩部撞擊症候群男性游泳選手肩關節疼痛及功能與生活品質的影響

摘要：在運動傷害中，由於涉及的器官和不同運動的特定模式，肩關節損傷是常見的。研究報告稱，30%–40%的運動員有慢性和急性肩痛症狀。在所有肩部損傷中，肩部撞擊症候群是導致肩部疼痛和功能受限的最常見原因。本研究旨在調查 8 週滑板訓練對患有肩部撞擊症候群的男性游泳運動員的疼痛、肩關節功能和生活品質的影響。這項研究的受試者包括 30 名患有肩部撞擊症候群的游泳運動員，以易於理解和有目的的方式進行選擇，分為兩組滑板

練習組（15 人）和對照組（15 人），從近距離動力學評估受試者的表現鏈上肢穩定性測試，疼痛程度來自視覺模擬量表問卷，生活品質來自 SF-36 生活品質問卷，平衡來自 Y 平衡測試。肌肉力量測量使用肌肉測力計，肩關節活動範圍測量使用測角儀。重複測量變異數分析測試以 $p<0.05$ 的顯著水準分析資料。結果顯示，滑板運動對疼痛、肩關節功能穩定性、上肢功能、肌力、肩關節活動度和生活品質有顯著影響（$p\geq0.05$），但在對照組在前測和後測（$p>0.05$）。肩關節夾擠症候群.

关键词：肩部撞擊症候群、肩關節功能、生活品質、游泳者、滑板訓練。

1. Introduction

Shoulder joint disorders are considered the third reason, after backache and neckache, forcing patients to go to hospitals and medical centers [2]. [31] reported that the prevalence of shoulder ailment symptoms, such as pain, was between 20% and 35%, and the incidence of shoulder pain by gender and age was 9.5 per 1000. The most common shoulder problem is rotator cuff dysfunction or tendinopathy, leading to rotator cuff tears, glenohumeral joint instability, and adhesive capsulitis [5]. Shoulder impingement syndrome and rotator cuff muscle tendonitis are among the most common causes of shoulder joint pain and disability. According to reports, shoulder impingement accounts for 44-65% of shoulder complaints [5]. Spontaneous remission of these disorders is usually not common, and they require proper therapeutic and rehabilitation measures [1], making shoulder impingement syndrome one of the adults' most common shoulder disorders.

The reason for shoulder impingement can be a characteristic pattern of muscle imbalance, including weakness of the lower and middle trapezius, serratus anterior, acromion, and deltoid muscles, along with muscle shortness of the upper trapezius, pectoralis major, and levator scapulae [18]. The deviation of movement patterns from standards is a primary cause of painful mechanical syndromes, and any change in these patterns results from movement repetition or sustained posture during daily or recreational activities. Accordingly, the main changes made because of this unnatural movement repetition include changes in the strength, stiffness, and length of the tissue, which changes the movement patterns of the joints and their interaction and results in microtrauma. This microtrauma eventually leads to joint and muscle–tendon injuries, pain, and disability [24].

Previous investigations have shown that therapeutic exercises lessen pain and disability in patients with rotator cuff tendinopathy [22]. Effective interventions include therapeutic exercises focusing on strengthening the rotator cuff and scapular stabilizers, stretching exercises to reduce capsule tightness, taping the shoulder, and teaching proper posture to the patient [1]. However, disagreement is still in the literature regarding the best intervention to treat shoulder impingement. A recently used therapeutic exercise for treating musculoskeletal disorders is the slide board training program [23], an essential component of a comprehensive training program. The slide board training program is a new type of exercise and rehabilitation that is considered a form of aerobic exercise focusing on moving the body in the frontal plane to activate the smaller, stabilizing muscles. Athletes properly support their larger muscle groups when they work with the smaller muscles during a slide board training program.

These exercises help the athlete move better and with less pain eventually. Lateral exercises draw attention to the stabilizing muscles of the body. The slide board is a portable, easy-to-use, inexpensive exercise machine applicable for several exercises and a great cardio workout. Slide boards are functional training devices, becoming a popular adjunct to ventilation and rehabilitation programs [21]. Most athletes enjoy using the slide board because it provides an incredibly fun and challenging way to perform low-impact aerobic exercise by sliding on a board [20]. The slide board training program engages the core of the body. [20] showed that a slide board increases muscle strength. [26] also reported that a slide board training program extends the range of joint movements. Slide boards increase the range of dynamic movements that require balance in all planes. Rehabilitating using a slide board allows the athlete to work in the sagittal, frontal, and transverse planes while moving. The slide board helps stabilize and strengthen the upper and lower body. To the best of our knowledge, no study has investigated the effect of a slide board training program on shoulder impingement syndrome. Therefore, this research seeks to answer the question: Can an 8-week slide board training program affect shoulder joint pain and function and the quality of life of male swimmers with shoulder impingement syndrome?

2. Research Method

This quasi-experimental and applied study included student male swimmers with shoulder impingement syndrome aged 18 to 24 years with proper general health conditions who passed the Empty Can and Hawkins Kennedy tests. All participants of this study were voluntary informed consent persons engaged in at least two years of regular sports activities. The exclusion criteria were:

– Any history of shoulder joint fracture and surgery,
– Irregular engagement in exercise programs (three alternating sessions or five successive sessions),
– Any musculoskeletal abnormalities in the spine and upper organs (kyphosis, forward head posture, dropped shoulder syndrome, and rounded shoulder),
– Voluntary refusal to participate in the research,
– Neck pain during rest,
– Pain during active neck movement,
– Failure to complete the research tests,
– Signs indicating that a person is uninclined to participate and cooperate adequately during the research period (detected by the researcher),
– Refusal to participate in more than 30% of training sessions, and
– Refusal to participate in the post-exam stages.

The 30 qualified athletes were selected as participants from the statistical population based on the inclusion and exclusion criteria in an accessible and purposeful manner and divided into two groups: an experimental (slide board training program) group (15 people) and a control group (15 people).

After the initial introduction, the subjects were invited for pre-test evaluation before the first week (pain, functional stability of shoulder joint, upper limb balance, muscle strength, range of shoulder motion, and quality of life) and body height and weight measurements repeating the same process eight weeks after completing the training protocol.

Data collection involved field study and questionnaire methods. To evaluate the participants' performance, we used the closed kinetic chain upper extremity test (CKCUEST), visual analog scale (VAS) questionnaire, SF-36 quality of life questionnaire, Y balance test (YBT), mouse dynamometer, and goniometer, evaluating upper limbs, the extent of pain, quality of life, balance, muscle power, and range of shoulder joint motion, respectively.

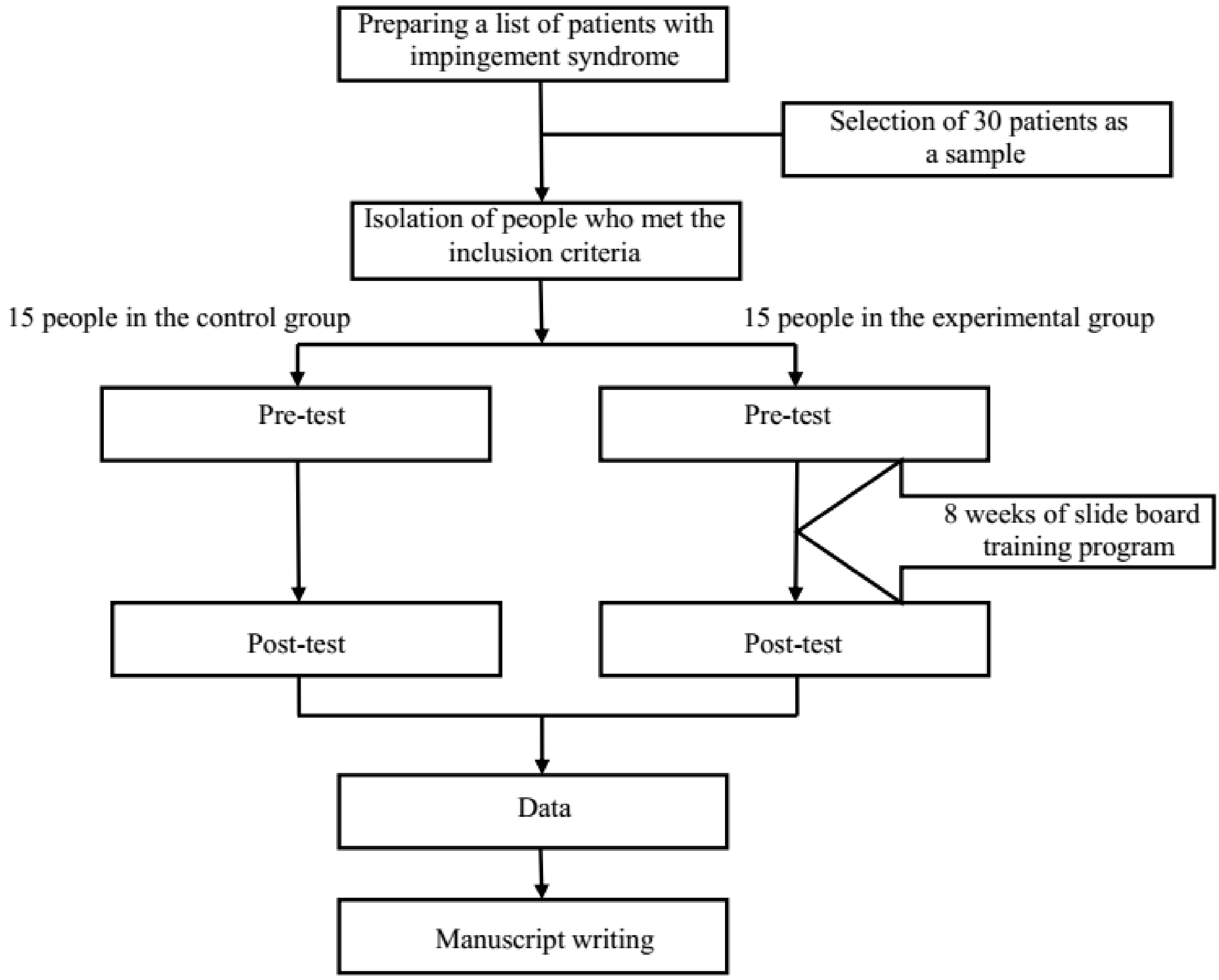

Fig. 1 Flowchart of the research methodology (Developed by the authors)

The 30 male swimmers with shoulder impingement syndrome were selected to participate in the present study based on the inclusion and exclusion criteria and after the approval of a specialist physician. The subjects were then informed about the research objective and method. The subjects willing to participate in the research completed and signed an "Informed Consent Form." Then, they participated in the study as subjects divided into experimental and control groups. Each group consisted of 15 subjects.

In the first stage of evaluations, we evaluated the functional stability of the shoulder joint, upper limb balance, muscle strength, range of shoulder motion, and quality of life, and the subjects completed the pain questionnaire. The next stage was their division into two groups. The experimental group subjects participated in a slide board training program for eight weeks and were asked not to perform any exercises other than in the mentioned therapeutic movement program. The experimental group members were allowed to perform their normal daily activities. In addition, all subjects were asked not to take painkillers to reduce knee pain during the training protocol. Subjects started their training program within one week maximum after their initial measurement session and attended the training sessions based on a schedule set at times that suited them and the researchers. The subjects wore suitable sports clothes to ease the exercises. The researchers directly supervised performing the exercises. Each subject participated in three training sessions every week. The experimental group had to attend at least 21 sessions, performing warm-ups at the beginning of each training session.

Subjects participated in the training program for eight weeks (three 30-to-50-minute sessions per week). After eight weeks of the training protocol, the evaluations performed before the training program were repeated, recording the values obtained in the evaluation table.

2.1. Evaluating the Range of Shoulder Motion

To evaluate the range of external rotation of the shoulder joint, each subject was lying on his back on the bed and should completely loosen the muscles of his shoulder girdle. The shoulder position was at 90 degrees of abduction on the edge of the bed, and the elbow was at 90 degrees of flexion perpendicular to the bed. By applying force on the subject's forearm, the examiner rotated the subject's shoulder joint externally and passively and released the forearm gently at the end of the range without applying any additional force [28]. The examiner placed the axis of the goniometer on the elbow joint so that the fixed arm was perpendicular to the ground and facing down, and the moving arm was along the median nerve of the forearm to calculate the range of external rotational motion of the shoulder.

To evaluate the range of internal rotation, the subject was lying on his back on the bed and should completely loosen the shoulder girdle muscles. The shoulder position was at 90 degrees of abduction on the edge of the bed, and the elbow was at 90 degrees of flexion perpendicular to the bed. By applying force on the subject's forearm, the examiner rotated the subject's shoulder joint internally and passively around the coronal axis. Then, the researcher placed his other hand on the acromioclavicular joint. Because the aim was to investigate the range of internal rotation of the glenohumeral joint, the examiner stopped rotating as soon as he felt any movement in the acromioclavicular joint, and another person fixed the position of the patient's hand. The examiner placed the axis of the goniometer on the olecranon so that the fixed arm was perpendicular to the ground and the moving arm was along the median nerve to measure the range of shoulder internal rotation around the coronal axis. To increase the accuracy of the measurement and reduce the error test rate, the steps of evaluating the range of the internal and external rotations of the shoulder joint were repeated three times, recording the average of the three obtained values [27].

2.2. Functional Stability of the Upper Limb

The Y balance test-upper quarter (YBT-UQ) measured the subjects' functional stability. The YBT-UQ is a field test that examines the unilateral dynamic performance of the upper limb in a closed chain of motion when stability during movement is required using minimal facilities and equipment [10, 32]. In this functional stability test, the subject lies on one hand while performing the three-point plank and performing reaching in three directions: medial reach direction, inferior-lateral reach direction, and superior-lateral reach direction, up to the maximum distance from the supporting hand, and the measurements are performed quantitatively [10]. This test, simultaneously measuring core and shoulder stability, requires balance, neuromuscular control, proprioception, strength, and various motions. It is an efficient and comprehensive method to determine the function, strength, or shoulder movement deficit. The UQ-YBT testing tool was a flat surface for placing the support hand, and three measuring rods were attached to it from three directions. There was a moving indicator on each rod moved using the free hand to measure the extent of reach in that direction. To perform this test, the subject placed the palms of the hands (thumb attached to the index finger and elbows in an open position) and the toes (bare feet) in the starting position and kept the spine and lower limb in one direction. A line shows where the thumb should be; the feet were shoulder-width apart. In this situation, the subject should reach the farthest possible place in the medial, inferior-lateral, and superior-lateral directions with his free hand while maintaining the position of the supporting hand, body, and lower limb. To compare a subject with other people, the reach values were normalized with the length of the upper limb (the distance from the spinous process of the 7th cervical vertebra to the end of the tallest finger when the shoulder is 90 degrees away and the elbow, wrist, and fingers are open) [6]. Reaching was performed in all three directions consecutively, without any rest, while the free hand was not in contact with the ground. After completing each round (reaching in 3 directions), the subject was allowed to place the free hand on the floor, rest, and perform this process three times [32].

In each round, if the subject's fixed hand was moving away from the flat surface, the free hand hit or rested on the ground or the indicator, or the subject was unable to control his free hand, return it to the starting position, or maintain his balance, or if each foot moved away from the ground, the round would be repeated [32]. The subjects performed two practice trials before testing. The maximum reach was recorded in each direction (up to 0.5 cm), and the following formula used obtained values to calculate the total composite score:

Composite score = Upper limb length × total score of all three directions/3

2.3. Upper Limb Function

CKCUEST evaluates upper body agility and stability. To perform the CKCUEST, two athletic tape markers 5 cm wide were placed in parallel 90 cm apart on the ground. At the start, the hands were on each athletic tape, and the subject was in the push-up position. Subjects should pass one hand across their body, reach the athletic tape under their opposite hand, and return to the initial starting position after touching it. The subjects repeated the same movement for the opposite hand over 15 seconds 3 times, recording the number of touches by both hands. The standard mean of this movement for women exposed to injury is 24 touches within 15 s, and any subject whose test result is less than this value is considered an injured subject. Before the test, subjects warmed up themselves for 4 min. The test identified the samples exposed to injury based on the obtained scores [29].

2.4. Muscle Strength

Movement strength measures used a handheld dynamometer (Nicholas Manual Muscle Test). To perform the isometric strength test of the external and internal rotation movements, the subject laid down on the stomach on the bed. The shoulder was at 90 degrees of abduction on the bed, and the elbow was at 90 degrees of flexion hanging from the bed (using a standard goniometer to measure the angles). A folded towel was under the arm. The dynamometer was on the front surface of the forearm, above the wrist for internal rotation, and on the back surface for external rotation. The subject should apply his maximum force to the dynamometer held by the examiner to rotate externally and internally. Then, the examiner recorded the maximal isometric force applied by the subject on the device's digital screen.

2.5. Slide Board Training Protocol

The training program lasted 8 weeks (three 45-minute sessions per weeke, each included 10 min of warm-up, 30 min of main exercises, and 5 min of cooling down (Table 1) [3, 23].

Table 1 Slide board training protocol (Developed by the authors)

Row	Exercises	Weeks 1 and 2	Weeks 3 and 4	Weeks 5 and 6	Weeks 7 and 8
1	Standing on the slide board and extending the arm using a theraband	10×3 repetitions	12×3 repetitions	16×3 repetitions	20×3 repetitions
2	Maintaining balance on the slide board and resisting the raband with hands from the sides	10×3 repetitions	11×3 repetitions	15×4 repetitions	20×4 repetitions
3	Maintaining balance on the slide board and resisting the raband with hands from the front	12×3 repetitions	15×3 repetitions	18×3 repetitions	20×3 repetitions
4	Maintaining balance on the slide board by moving a poke between two plates and resisting the raband and arm flexion using a theraband	12×3 repetitions	15×3 repetitions	18×3 repetitions	20×3 repetitions
5	Maintaining balance on the slide board and flexing the arm using a theraband	12×3 repetitions	15×3 repetitions	18×3 repetitions	20×3 repetitions
6	Maintaining balance on the slide board by moving the poke between the two plates and keeping hands at the horizon from the sides	12×3 repetitions	15×3 repetitions	18×3 repetitions	20×3 repetitions
7	Maintaining balance on the slide board by moving a poke between the two plates and holding hands at the horizon level from the front	12×3 repetitions	15×3 repetitions	18×3 repetitions	20×3 repetitions

The data of this study were obtained through the evaluation of variables using SPSS Statistics 26. Moreover, descriptive and inferential statistics described variable and data analysis, respectively. In the descriptive statistics section, graph, mean, and standard deviation tables were used. The Shapiro–Wilk test assessed the normality of data distribution in both groups. If the data were normal, repeated measures ANOVA was used to examine the effect of the slide board training program on variables in the groups.

3. Results

Table 2 shows descriptive information related to the research variables (age, height, and weight).

Table 2 Mean and standard deviation of the subject's descriptive data, 15 people per group (Developed by the authors)

Index	Group	Mean	Standard deviation	t value	Significance level
Age (years)	Experimental	25.6	5.3	2.95	0.14
	Control	26.4	5.6		
Height (m)	Experimental	1.71	0.1	1.98	0.23
	Control	1.7	0.04		
Weight (kg)	Experimental	71.2	0.1	3.95	0.24
	Control	72.4	0.04		

This study examined the effect of 8 weeks of slide board training on pain rate, functional stability of the shoulder joint, upper limb balance, muscle strength, range of shoulder motion, and quality of life of male swimmers with shoulder impingement syndrome using repeated measures ANOVA test.

The results of the repeated measures ANOVA test showed that after eight8 weeks of slide board training, intragroup, intergroup, and interactive effects were significant on pain rate, functional stability of the shoulder joint, upper limb balance, muscle strength, range of shoulder motion, and quality of life ($p<0.05$). That is, the number of variables changed significantly under the effect of the slide board exercises. In addition, the results showed that there was a significant difference between the experimental and control groups ($p > 0.05$) (Table 3).

Table 3 Descriptive data and repeated measures ANOVA test for measuring pain rate (Developed by the authors)

Variable	Test	Experimental group (n=15)	Control group (n=15)	Intragroup changes	Intergroup changes	Interaction
Shoulder joint function	Pre-test	0.01±0.71	0.02±0.70	F=14.05	F=16.052	F=12.01
(No.)	Post-test	0.02±0.73	0.05±0.7	P=0.002	P=0.001	P=0.03
Pain	Pre-test	0.1±7.14	1.1±7.22	F=12.05	F=9.052	F=50.01
(Score)	Post-test	1.47±5.7	1.4±7.67	P=0.002	P=0.01	P=0.002
Internal rotation	Pre-test	4.2±10.1	2.2±11.1	F=36.05	F=21.052	F=44.01
strength (Newton)	Post-test	4.2±15.1	3.2±10.1	P=0.01	P=0.03	P=0.002
External rotation	Pre-test	1.3±9.6	0.3±9.3	F=19.05	F=13.052	F=48.01
strength (Newton)	Post-test	2.1±14.5	1.4±9.2	P=0.002	P=0.01	P=0.003
Functional stability of	Pre-test	0.01±0.71	0.02±0.70	F=34.05	F=18.052	F=12.01
the upper limb (cm)	Post-test	0.02±0.73	0.05±0.7	P=0.002	P=0.005	P=0.02
Range of internal	Pre-test	2.2±33.21	3.2±34.1	F=39.05	F=17.052	F=9.01
rotation (degrees)	Post-test	1.2±40.1	4.2±32.1	P=0.002	P=0.005	P=0.04
Range of external	Pre-test	3.2±73.21	4.3±71.6	F=11.05	F=17.052	F=13.01
rotation (degrees)	Post-test	3.1±82.21	3.2±72.14	P=0.003	P=0.001	P=0.02
Quality of life	Pre-test	2.02±60.57	2.7±61.8	F=30.05	F=22.2	F=36.01
(Score)	Post-test	1.5±69.41	1.3±62.6	P=0.02	P=0.01	P=0.001

The results of the repeated measures ANOVA test showed that there was a significant difference between the two groups regarding pain rate, functional stability of the shoulder joint, upper limb balance, muscle strength, range of shoulder motion, and quality of life ($p<0.05$) (Table 3). Therefore, based on the mean score, the slide board training program significantly affected pain intensity, functional stability of the shoulder joint, upper limb balance, muscle strength, range of shoulder motion, and quality of life.

4. Discussion

The results showed that after eight weeks of workouts with a slide board, pain intensity, functional stability of the shoulder joint, upper limb balance, muscle strength, range of shoulder motion, and quality of life significantly decreased in the experimental group. This study used the slide board training program to improve the symptoms of patients with shoulder dislocated syndrome.

In 2022, a study showed that strength training and home exercises can reduce pain and improve the range of motion [25]. A recent review also indicated that supervised and self-training lessened pain and improved function equally. Moreover, trained patients with subacromial pain syndrome can get well sooner than non-trained patients [15]. A recent systematic review revealed that supervised physiotherapy and home-based progressive shoulder strengthening and stretching exercises involving the rotator cuff and scapula muscles were equally effective in conservatively treated patients with SIS [11].

The results of traditional exercises agreed with [30], which claimed that these and strength exercises improve swimmers' fitness. [1] also reported that a combination of exercises and physiotherapy improves strength and reduces pain in ordinary people with impingement syndrome. However, the results were inconsistent with those obtained in [12], which investigated the effect of 6 weeks of strengthening training on shoulder strength and did not observe any significant changes in muscle strength. It appears that exercise can improve symptoms in people with shoulder impingement syndrome. As for sports physiology, the minimum time required for muscle strength adaptations is four to six weeks. On the other hand, [12] evaluated flexion and abduction strength, and this study also evaluated rotator muscle strength. In this study, changes in the means proved the effectiveness of a slide board training program on the strength of the shoulder muscles. These results agree with those obtained by the authors of [12], who believe that muscle groups in injured people act uncoordinated. They proposed that muscles need rebuilding through isolated movements. They argue that an isolated exercise that strengthens a muscle causes muscular stretch simultaneously in another patient, and several sets of movements and muscles are necessary instead of separate and isolated exercises to restore strength and balance to muscles. [12] also proposed that a few weeks after starting the strength training period, strength and movement exercises should replace separate and isolated exercises to strengthen the deltoid muscles and external rotators, increase the stability of the humeral head, and balance the ratio of the strength of the shoulder rotator muscles that control the movements of the humeral head. This displacement control ultimately improves impingement syndrome [14]. Because of the weakness of the external rotator muscle strength of the subjects with shoulder impingement syndrome, the authors put more emphasis on the external rotator strengthening exercises.

Studies have shown that in the case of musculoskeletal pain caused by motor control disorder, improvements will be seen in these people when there is a motor control improvement [17]. Different methods to improve motor control exist, including exercise [13]. Previous studies have indicated that the necessary coordination can occur when the external muscles are activated using sports exercises to strengthen the lower limbs, which also results in clinical improvement [7].

According to the above, the slide board training program used in the present study improved the movement control of the muscles around the shoulder joint, thereby reducing the delay in the start of muscle activity and increasing coordination. In any case, what is clear about the current research is that the exercises used in this research (slide board workouts) improved muscle strength by changing the movement control of the muscles around the shoulder joint, which can be considered one of the influencing factors on the control and treatment of shoulder impingement.

In addition to the mentioned cases, the statistical test results showed that after eight weeks of training (in the post-test stage), the pain in the training groups was significantly less than in the control group. Because the literature contained no similar research that emphasized the effect of slide board exercises on the research variables, the present results are incomparable with the results of any other study. As previously stated, the training protocol can improve the motor control of the muscles around the shoulder joint; therefore, after eight weeks of slide board training, the pain would decrease in the experimental group.

The results of this study indicate that the internal and external rotator muscles require rehabilitation exercises for at least eight weeks to achieve maximum motor control. This result agrees with the findings of [8], which stated that neuromuscular exercises are effective in restoring maximum muscle efficiency.

The results of the present study also showed that after eight weeks of slide board workout, the range of motion increased significantly in the experimental group ($p<0.05$), while significant change was absent in that of the control group ($p>0.05$).

Range of motion is the ability to flex around a specific joint or group. Most daily activities require a good range of motion or flexibility in the respective joints. In everyday life, a person must have a good range of motion and flexibility in muscles and joints to perform life skills and prevent injuries. Various factors can cause a limitation or decrease in the range of motion in a specific joint. Because the bone structures in all people are almost the same and due to the role of other factors, these structures can partially limit the joint range of motion of each person; however, factors such as muscles, skin, tendons, and sheaths surrounding the joint, and connective tissues and fat tissue surrounding the joint (such as ligaments and joint capsule) are another reason for this limitation [16, 19]. Injuries and illnesses are another significant factor in determining the range of motion. People with shoulder impingement only perform limited movements based on their level, lifestyle, and sports performance in their daily lives. Therefore, these individuals can have a more limited range of motions than healthy individuals. As mentioned, reduction of flexibility and joint stiffness are among the characteristics of inactivity syndrome. Another sign of this complication is tightness of the ligaments and joint capsule, which reduces the range of motion in the joints [25].

One factor that appears to affect shoulder joint imbalance is the function of the muscles around the shoulder joint. In anatomical position, the muscles around the shoulder joint stabilize and maintain the proper position of the shoulder and shoulder joint and also help the shoulder move during their combined and opposite actions. After shoulder impingement disorder, the range of joint motion decreases, which may be due to immobility. Factors that can delay or prevent regaining the normal range of motion include improper surgery, contractile development and tightness of the capsule or ligament, and muscle resistance [19]. In most studies, patients with shoulder impingement after rehabilitation programs had a deficit in supraspinous muscle strength. This weakness is due to defects in the gamma ring of the patients’ muscle spindle receptors caused by sensory afferents.

The results showed a significant difference in the motion range of the subjects in the experimental and control groups.

Postural chain mobility depends on anatomical (range of motion) and physiological (muscle activity) factors. According to the literature, postural disorder occurs in patients with shoulder impingement due to reduced motion range of the shoulder joint. So far, limited studies exist on the effect of training protocol interventions on the range of shoulder joint motion in patients with shoulder impingement. However, some studies have compared this in healthy and injured individuals.

The results showed exercise effectiveness in reducing joint pain and range of motion in male athletes with shoulder impingement. In addition, a slide board training program should be an essential part of the rehabilitation program to accelerate and facilitate the treatment of patients with shoulder impingement.

The results of this study also showed that after eight weeks of slide board training, functional stability, and upper limb function improved significantly in the experimental group ($p<0.05$), but no significant change was observed in the control group ($p>0.05$). Based on the findings of this study, the athletes in the experimental group had better functional stability and upper limb function in tests performed on them compared with the athletes in the control group. The results of this study were inconsistent with some of the UQ-YBT results on 20 water polo players [33]. These researchers observed a significant difference in the score of superior lateral reach direction of these athletes and attributed this difference to the functional stability of the non-dominant limb in water polo players. They stated that because the superior limb of the participants in the study is dominant and stronger, and the role of the supporting hand in the surpassing lateral reach direction is very similar to that of the non-dominant hand in stabilizing the body during passing and shooting water polo balls, this difference was significant. Of course, this stabilizing role is absent in volleyball skill patterns, so as is the consensus of most previous studies, this study also assumes that although there is little evidence of people's willingness to make more use of non-dominant limbs to stabilize [9], this difference is not so remarkable to be considered a significant difference in the UQ-YBT test whose reach is mainly in the median range of the shoulder motion. Studies that have observed improvement in dynamic balance following core stability exercises in part proved the importance of the role of core body stability. Therefore, increasing shoulder joint stability results from the increased stability of core body muscles. Specialized exercises that stabilize the core may increase the force, neuromuscular coordination, motor control accuracy, proprioception, joint stability, muscle co-contraction, and reaction time, mainly resulting in a marked increase in muscle function.

Finally, given the complex biomechanics of the shoulder, the researchers of this study expected that the slide board training program, consisting of a set of comprehensive exercises focusing on restoring the mobility and strength of the scapular muscles and rotator cuff tendons, would be a suitable training program for improving symptoms in patients with shoulder impingement syndrome. Therefore, slide board workouts and training can increase functional stability and upper limb function in patients with shoulder impingement syndrome.

5. Conclusion

The study found that a slide board training program significantly affected pain, muscle strength, and range of shoulder motion in the experimental group but not in the control group. Based on these results, the authors recommend using slide board exercises and training programs in rehabilitation for patients with shoulder impingement syndrome.

This study encountered some limitations. First, the study only included male swimmers with shoulder impingement syndrome, which limits the generalizability of the findings to other populations. Second, access to participants and adherence to time constraints caused difficulties in monitoring and evaluating the study results. Third, the study did not include a follow-up period to assess the long-term effects of the slide board training program.

Various resources are available for shoulder rehabilitation exercises, including slide board exercises; therefore, we recommend using these exercises and training programs in the rehabilitation stages for patients with shoulder impingement syndrome.

To further enhance the research on the effect of slide board training on shoulder impingement syndrome in swimmers, the following recommendations can be considered: female participation, electromyography(EMG) analysis, and follow-up tests.

Acknowledgments

This article is a part of a doctoral dissertation conducted at Isfahan University. The participation of all research subjects in this study is cordially appreciated.

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