ORIGINAL ARTICLE

Nr 2023;13 (2):344-352

Shoulder Function in Swimmers with and without Scapular Dyskinesia

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DOI: 10.32098/mltj.02.2023.19

LEVEL OF EVIDENCE: 3

SUMMARY

Background and purpose. Considering the importance of the effect of scapular dyskinesia on movement patterns and performance in swimmers, it conducted this study to investigate shoulder function in swimmers with and without scapular dyskinesia.
Materials and methods. The present study was cross-sectional and included sixty professional male swimmers between 18 and 30 years old with and without scapular dyskinesia. McClure's test was used to identify people with scapular dyskinesia. It took a caliber test to measure the brachial scapular rhythm. SPSS 23 software was used for analysis. Independent t-test was used to examine the difference between groups at a significance level of 0.05.
Results. The results showed a significant difference between the feeling of shoulder joint position at 45 and 135-degree angles in swimmers with and without scapular dyskinesia ($p < 0.05$). There is a significant difference between the functional stability of the upper limbs of swimmers with and without scapular dyskinesia ($p < 0.05$). Also, there is a significant difference between the perception of shoulder joint strength of swimmers with and without scapular dyskinesia ($p < 0.05$).
Conclusions. Identifying the effects of dyskinesia on the sense of shoulder joint position, functional stability, and sense of force perception as one of the risk factors and as a target point for prevention and preventing the risk of chronic injuries in these people.

KEY WORDS

Shoulder; function; swimmers; dyskinesia; scapular.

INTRODUCTION

The shoulder complex is designed to achieve the greatest range of motion (ROM) with the most significant degrees of freedom of any joint system in the body (1). Hypermobility of the shoulder at the glenohumeral and scapulothoracic joints is balanced by the stability of the acromioclavicular and sternoclavicular joints. A complex ligamentous system contributes to primary stability at the glenohumeral joint, and a complex muscular ligamentous system acts as a secondary stabilizer. This support mechanism allows the shoulder to withstand large external forces while providing sufficient mobility for the upper extremity to perform complex movement patterns (2). A superb example of balance between shoulder mobility and stability occurs in sports that require overhead movements. Many overhead sports, such as throwing, racquets, and volleyball, require two or three overhead movement patterns (3).

Conversely, swimming requires multiple overhead movement patterns that include continuous clockwise and counterclockwise rotation of the arm. A competitive swimmer typically performs more than 4,000 strokes per shoulder in a single workout, making the sport a common source of shoulder pathology, and shoulder pain is the most common musculoskeletal complaint in swimming (4, 5).

With sports development and people's tendency towards championship sports, sports injuries have increased, making researchers focus on discovering the causes of injuries (6). A good posture requires the coordination of different body parts, and one of the parts that play an essential role in maintaining a good posture is the scapula. Improper movement of the scapula during shoulder movement is called scapular dyskinesia and is a neglected cause of pain and dysfunction. Scapular dyskinesia can be clinically characterized by medial or infero-medial ridge protrusion, scapular elevation or initial (earlier) elevation during arm elevation, or rapid downward rotation during arm abduct (7). Scapular dyskinesia was reported in 68% of patients with rotator cuff problems, 94% of patients with glenoid injury, and 100% of patients with glenohumeral instability (8). Scapular dyskinesia syndrome means (days: changes, kens: movement) changes in the movement and position of the scapula, which can be associated with shoulder syndrome. The only bone stabilizer of the scapula is the clavicle, and the proper functioning of the muscles plays an essential role in the stability of the scapula. Significant clinical findings have shown that changes in the position and movements of the scapula cause the scapula to become prominent concerning the trunk during movement or rest. A muscle imbalance between the upper trapezius and serratus anterior muscles mainly causes scapular dyskinesia (9-11). The scapula is a vital part of the upper extremity kinematic chain and a critical component of the glenohumeral rhythm, a significant determinant of upper extremity efficiency. Overhead athletes are at a higher risk of developing scapular dyskinesia. Although swimming is considered an overhead sport, information on scapular dyskinesia in these athletes is limited (12, 13). Considering the critical role of the shoulder in every aspect of shoulder movements, its natural position, and placement on the chest in both static and dynamic states is essential to performing arm movements and preventing shoulder injuries in swimmers (14). The research shows that most sports injuries in swimmers occur in the upper limbs and especially in the shoulder joint. One of the most common injuries in this area in these people is the swimmer's shoulder syndrome, which is the result of tissue entrapment in the subarachnoid area, and one of the risk factors for this injury is scapular dyskinesia syndrome (15). The anterior dentate muscle is a stabilizing and moving muscle in this area. The lower and middle parts of the anterior dentate muscle, with the front and enamel parts of the trapezius muscle form a power couple that controls the rotation and coordination in the movements of the scapula. As the arm moves into abduction, the scapula rotates upward to provide adequate space for the structures under the occipital arch (11, 16, 17). Suppose scapular dyskinesia is related to the disorder of scapular muscle strength due to scapular instability. In that case, changes in scapular movement in people with scapular dyskinesia are permanent, or these changes increase as the load on it increases (18). Swimmers are constantly exposed to shoulder and back injuries, so applying unnatural forces to overcome the water resistance is known to be one of the possible causes of this injury. The high prevalence of shoulder injuries in swimmers and the alarming consequences show the necessity of knowing the risk factors and the exact mechanisms of this injury, as well as identifying people at risk and applying preventive measures (19). Recent research has shown the pivotal role of the scapula in shoulder function, shoulder injury, and shoulder rehabilitation. This knowledge helps the physician provide more comprehensive care for the athlete. Usually, swimming represents a competitive sport. However, the current literature on the prevalence of scapular dyskinesia in swimming is limited. The majority of shoulder pain among competitive swimmers is high, but there are no guidelines for reducing shoulder injuries. Elucidating the differences between swimmers with and without shoulder pain can be a basis for developing a program to prevent shoulder injuries that may lead to pain and impaired performance (20). Due to the importance of injury risk factors such as scapular dyskinesia on movement patterns, it is necessary to identify the impact of this defect on the ability of swimmers so that by identifying it as one of the risk factors, it can be placed as a target point for prevention exercises and the risk of injuries prevent chronic disease in these people. Considering that defects in movement patterns can cause changes in the movement chain and potentially lead to injuries, it is important to identify and address these issues early on. This can help prevent more serious injuries from occurring, such as swimmers' shoulder injuries. By identifying these issues in an athlete's movement patterns and taking appropriate measures to address them, can coaches and health professionals prevent injuries before they occur?

MATERIALS AND METHODS

The current cross-sectional study was conducted on 60 professional male swimmers (a professional athlete is someone who must devote at least three hours to her/his specialized training during the day) (n = 30) with scapular dyskinesia and (n = 30) without scapular dyskinesia, 18-30 years old (1). The criteria for entering the study included having a continuous 3-year experience in swimming, having a Body Mass Index (BMI) (kg/m^2) of 18.5 to 25, not having any abnormalities affecting the research process (such as kyphosis, scoliosis, reclined back, uneven shoulder), and completing the consent form to participate in the research. The exclusion criteria for the participants were an age group higher than the purpose of the study, lack of consent to cooperate in the research process, and causing any pain during the work process.

The Ethical Committee of Hamadan University of Medical Sciences approved the study (IR.UMSHA.REC.1401.218 – Date of approval: May 21, 2022).

Data collection

After completing the consent form by the research subjects in the Tehran University gym club, swimmers warm up period before identifying the scapular dyskinesia. McClure's test was taken from the issues to identify scapular dyskinesia (percentage of agreement McClure's test was between 75% and 82%, and ϰw ranged from 0.48 to 0.61 (21)) in such a way that the researcher placed two dumbbells weighing 1.5 kg in both hands of the subjects. The person was asked first to raise his arms from zero degrees of flexion to 180 degrees of arm extension and after a 3-second pause, return his hands to the first position. At this time, the researcher stood behind the subject and observed the movement of the athlete's shoulder (the athlete did not have any clothes on his shoulder). If the athlete has scapular dyskinesia, the inner edge of the scapula is separated from the trunk, and the scapula has undergone internal rotation. Then the Kibler test was taken from the athletes to measure the brachial scapular rhythm. This test was performed in three positions of 0, 45, and 90 degrees of the arm, and based on the modified method, the distance from the lower angle of the scapula to the nearest vertebral spinous process was measured in each of the tips of the arm. By subtracting the 45 and 90 curves from the zero-degree angle in the measurements, a difference of more than 1.5 mm was recorded as external rotation, and a difference of less than 1 mm was recorded as internal rotation.

Kibler *et al*. were pioneers in the classification of scapular dyskinesia. Up to today, the 4-type classification is the most commonly used method in scientific studies to determine if participants display scapular dyskinesia or not. The 4-type classification has been evaluated regarding its reliability by the author himself. They found intra-rater reliability of k = 0.5 and inter-rater reliability of k = 0.4. This means that this method is moderately reliable (22, 23).

Then the subjects were asked to fill DASH questionnaire and the Nordic questionnaire.

The upper body Y test was used to quantitatively evaluate the ability of a person to perform this test. The person was asked to complete the reach operation with the free hand while the other was in a weight-bearing position in internal, inferior-external, and superior-external directions. The stability of the supporting hand was evaluated, while the mobility of the trunk and reach was assessed. During each exercise, shoulder stability and mobility, trunk rotation, and blind area stability were involved. A person needs more balance, proprioception, strength, and range of motion to reach an area outside the surface of the remote support. For normalization in the upper body test, the person was asked to abduct the arm to 90 degrees, and then the distance between c7 and the tip of the person's middle finger was calculated using a tape (KOMELON company) measure. The score in each direction was calculated based on the average of three successful attempts that were normalized. First, the more significant normalized score in each order obtained from three repetitions was summed to calculate the combined score. Then the more essential efforts in all three principles were added together. And divided by three and multiplied by 100, the individual's combined score was extracted to determine the individual's overall performance in this test.

To measure functional isometric strength, all tests were performed with a prone position on the floor using a 4 cm foam block with the person's forehead resting on it. And data analysis was done. In Test I, the shoulder was in full abduction (in line with the body), the forearm was in pronation, and the heel of the hand acted as the main point of contact with the force plane. In the Y-test and the T-test, the arm was 135 degrees and 90 degrees in shoulder abduction, respectively. In all tests, the elbow was fully extended (**figure 1**).

After a standard warm-up consisting of two submaximal efforts from 0% to 90% in each test position, subjects

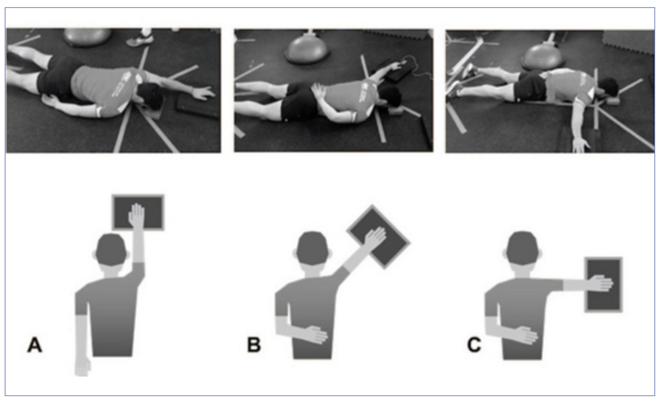

Figure 1. Measurement of functional isometric strength.

performed three attempts in three different places on the same limb. Then this procedure was repeated with the opposite limb. For the Y and T-tests, the opposite arm was placed behind the back so that the elbow does not touch the floor or cause trunk rotation. But in Test I, the arm was allowed to remain at the subject's side due to lower body rotational forces.

Data analysis

The statistical method used in this research included descriptive and inferential statistics. We were considering the normality of data distribution to compare two groups, independent t-test was used at a significance level of 0.05. All statistical analysis was performed using SPSS version 24.

RESULTS

Descriptive information related to the age, height and weight of the subjects is shown in **table I**.

Descriptive information related to research variables is shown in **table II**.

The Kolmogorov-Smirnov test was used to determine the normality of data distribution. Based on this test, the distribution is expected when the P-value is greater than the critical number at the 0.05 level. The results of this test showed that the distribution of all research variables was normal. To compare the feeling of the shoulder joint position in swimmers with and without scapular dyskinesia, an independent t-test was used, the results of which are presented in **table III**.

According to the statistics and the significance level of the independent t-test between the feeling of the shoulder joint position at angles of 45, There is a significant difference between 135 degrees of swimmers with and without scapular dyskinesia ($p > 0.05$). This means a significant difference exists between swimmers' sense of shoulder joint position with and without scapular dyskinesia. An Independent t-test was used to compare the perception of shoulder joint force in swimmers with and without scapular dyskinesia. According to the statistics and significance level of the independent t-test ($t = -3.24$ and $p = 0.002$), it was determined that there is a significant difference between the feeling of shoulder joint strength of swimmers with and without scapular dyskinesia. To compare the functional stability of the upper limb in swimmers with and without scapular dyskinesia, an independent t-test was used. According to the statistics and significance level of the independent t-test ($t = 2.27$ and $p = 0.026$), it was found that there is a significant difference between the functional stability of the upper limbs of swimmers with

Table I. Distribution of mean and standard deviation of age, height, and weight in different groups.

Variable	Group	Number	Mean ± SD
Age	Swimmers without scapular dyskinesia	30	22.80 ± 3.39
	Swimmers with scapular dyskinesia	30	24.10 ± 3.85
Weight	Swimmers without scapular dyskinesia	30	59.36 ± 6.69
	Swimmers with scapular dyskinesia	30	59.73 ± 4.73
Height	Swimmers without scapular dyskinesia	30	165.30 ± 10.39
	Swimmers with scapular dyskinesia	30	164.23 ± 10.17

Table II. Average distribution and standard deviation of research variables in different groups.

Variables	Group	Mean ± SD	
Sense of the position of the shoulder joint	45 dg	Swimmers without scapular dyskinesia	3.76 ± 1.85
		Swimmers with scapular dyskinesia	5.63 ± 2.20
	135 dg	Swimmers without scapular dyskinesia	4.73 ± 2.06
		Swimmers with scapular dyskinesia	6.70 ± 1.80
Sense of shoulder joint strength		Swimmers without scapular dyskinesia	6.43 ± 2.73
		Swimmers with scapular dyskinesia	8.93 ± 3.20
Functional stability of the upper limb		Swimmers without scapular dyskinesia	83.17 ± 5.85
		Swimmers with scapular dyskinesia	80.00 ± 4.88

Table III. Independent t-test results on the sense of position and perception of force in the shoulder joint and functional stability of the upper extremity of swimmers with and without dyskinesia.

Variable	Levene's Test		Independent *t*-test			
	F	p	Mean difference	t	Degrees of freedom	p
45 dg	1.070	0.303	-1.86	-3.55	58	0.001
135 dg	0.780	0.380	-1.96	-3.92	58	< 0.001
Understanding force	0.780	0.380	-2.50	-3.24	58	0.002
Performance Stability	0.820	0.368	3.16	2.27	58	0.026

and without scapular dyskinesia. The mentioned items are shown in **table III**.

DISCUSSION

This study investigated shoulder function in swimmers with and without scapular dyskinesia. Results of studies on whether scapular dyskinesia is a cause or a symptom of shoulder functional pathology vary, but it is believed to be a risk factor for further injury (24). The role of the scapula in upper extremity function has received considerable interest in recent years as our knowledge of the shoulder and surrounding structures has increased. The scapula plays several roles in facilitating optimal shoulder function when scapular anatomy and biomechanics interact to produce efficient movement. In normal upper-quarter function, the scapula provides a stable base from which glenohumeral mobility occurs. Stability at the scapulothoracic joint depends on the surrounding musculature. The scapular muscles must dynamically position the glenoid so that efficient glenohumeral movement can occur. When weakness or dysfunction is present in the scapular musculature, normal scapular positioning and mechanics may become altered. When the scapula fails to perform its stabilization role, shoulder function is inefficient, which can result not only in decreased neuromuscular performance but also may predispose the individual to shoulder injury. Clinical identification focuses on visual observation and examination procedures. It is thought to be more common in overhead athletes due to their reliance on unilateral upper extremity function, but its incidence has been unknown. According to the obtained results, as expected, we found a significant difference between the sense of shoulder joint position of swimmers with and without scapular dyskinesia (25).

In Matthew *et al.*'s systematic study, twelve studies including 1,401 athletes (1,257 overhead and 144 non-overhead; average age 24.4 ± 7.1 years; 78% male) were analyzed. They reported Scapular dyskinesia was found to have a greater reported prevalence (61%) in overhead athletes compared with non-overhead athletes (33%) (26).

In Jacopo *et al.*'s study, to determine the prevalence of scapular dyskinesia in asymptomatic young and elite swimmers, a total of 661 asymptomatic elite swimmers were examined for scapular dyskinesia, using a dynamic test consisting of examining the shoulder blades throughout the forward bending movement at the same time. The sagittal plane was evaluated and considered as present or absent. Scapular dyskinesia was diagnosed in 56 participants (8.5%). Type I scapular dyskinesia was the most common (46.5%). Male participants were twice as likely as female participants to have scapular dyskinesia, and no association was found between the dominant limb and the affected side ($p = 0.258$). Instead, a correlation was found between the breathing side and the affected side, such that swimmers with a preferred breathing side were more prone to develop scapular dyskinesia in the opposite shoulder ($p < 0.05$). Swimmers participating in long-distance events were found to be at higher risk of developing scapular dyskinesia ($p = 0.01$). Their results showed that scapular dyskinesia may be an asymptomatic condition in young elite swimmers and are present in 8.5% of these athletes. Early diagnosis may be useful for asymptomatic athletes with scapular dyskinesia and prevent its possible evolution into a symptomatic disease, which is in line with the aim of our study (12). In this regard, Tate *et al*. in one study, a sample of 142 collegiate athletes (National Collegiate Athletic Association Division I and Division III) participating in sports that required the use of the arm was rated and 66 of them underwent 3D. The kinematic data of both groups were evaluated through multivariate analysis of variance with *post-hoc* test and using the least significant difference method to compare the relationship between symptoms and scapular dyskinesia with odds ratio. The difference between the two groups of normal and overt dyskinesia was determined. Participants with overt dyskinesia showed higher scapular rotation ($p < 0.001$), lower clavicle height ($p < 0.001$), and greater clavicle extension ($p = 0.044$). The presence of shoulder symptoms did not differ between normal and overt dyskinesia volunteers (OR 0.79, 95% CI 0.33-

1.89). Subjects with scapular dyskinesia had less upward rotation during shoulder abduction and also reported a greater increase in an anterior tilt. In the present study, it was found that after performing interventional exercises, shoulder rotation increases and anterior tilt decreases in people with dyskinesia (27). In this connection, Huang *et al*. studied kinematics and muscle activity in people with scapular dyskinesia. A vision-based method was used to evaluate participating athletes with unilateral shoulder pain. Scapular movements during raising/lowering of arms as a single abnormal pattern (inferior angle protrusion - pattern I; medial edge protrusion - pattern II; excessive/insufficient scapular extension or upward rotation - pattern III), mixed patterns. They are classified as abnormal or normal patterns (fourth pattern). Scapular kinematics and related muscle activation were investigated with an electromagnetic motion recording system and surface electromyography. The results showed that the internal rotation of the scapula was observed more in people of pattern II and mixed pattern I than in control people when lowering the arm. The posterior tip of the degree was less in model I during the abduction of the arm. Upper trapezius activity was observed in individuals with pattern II during arm lowering. In addition, inferior trapezius and anterior serratus activity were lower in subjects with a brief pattern I and II during arm lowering. Specific changes in scapular muscle activation and kinematics were observed in different patterns of scapular dyskinesia. These findings also support using a comprehensive classification test to assess scapular dyskinesia, especially in the adduction phase (28). Another study, the results of which can be considered consistent with this study, is the study by Ou *et al*., in the study of scapular kinematic changes and related muscle activation in people with scapular dyskinesia. To investigate whether people with symptomatic scapular dyskinesia can achieve optimal movements and related muscle activities through conscious control, this research was conducted on 60 subjects with scapular dyskinesia (16 lower angles pattern I, 16 internal border pattern II and 28 mixed patterns) performed three selected exercises (arm elevation, lateral elevation, and passive external rotation) with and without conscious control. Three-dimensional electromagnetics and electromyography recorded scapular kinematics and muscle activation during the exercises. became. For scapular kinematics, a significant increase in scapular external rotation with conscious control during arm elevation and lateral arm elevation was observed in three groups. A significant increase in the activation of the middle and lower trapezius with conscious control was observed in the three exercises among the dyskinesia group. Increased serratus activation was found in the concentric phase of lateral external rotation in the pattern I and I+II groups. Conscious control of the scapula can improve scapular orientation and activation of the middle and lower trapezius and serratus during three selective exercises in subjects with symptomatic dyskinesis. To change, specifically, conscious control during external limbic rotation can increase serratus activity in the pattern I and I+II dyskinesias (29). In a study, Zandi *et al*. compared the functional stability of dominant and non-dominant shoulders in female volleyball players with and without anterior shoulder instability using YBT-UQ. In this study, the upper fourth balance test (YBT-UQ) was used to measure the functional stability of the dominant and non-dominant shoulders. After examination, the YBT-UQ composite score was higher in the non-dominant shoulder and the dominant shoulder of the healthy group and the non-dominant shoulder and the dominant (damaged) shoulder of shoulder instability, respectively. No significant difference was observed between the healthy group's functional stability of both shoulders ($p = 0.144$). In contrast, the functional stability of the non-dominant shoulders of the instability group was significantly higher than the unstable dominant shoulders ($p = 0.001$). The functional stability results of the unstable shoulders of the injured group were significantly lower than the results of the dominant shoulders of the healthy group, while on the non-dominant side, all directions except the supernumerary direction showed a significant difference. According to the results of this study, the functional stability of the unstable shoulder of university female volleyball players is lower than the functional stability of their non-dominant side or the functional stability of healthy people (30). In their study, Khaki *et al*. (31) found that athletes had a significant difference in the range of internal rotation ($p = 0.00$), less external rotation ($p = 0.02$), and more external rotation ($p = 0.02$) in the dominant shoulder compared to the non-dominant shoulder and compared to non-athletes ($p = 0.00$). The study also investigated the changes in range of motion in the rehabilitation of joint injuries and how it changes before shoulder injuries in throwing athletes, as well as the challenges of post-injury rehabilitation. The results showed that the range of shoulder rotation of throwers is shifted towards more external rotation and less internal rotation due to microtrauma caused by repeated throwing. These changes, which are not related to the type of throwing (upper arm or underarm), are one of the causes of shoulder pain in athletes (31). However, these findings are not consistent with the results of our study. In another study by Kibler *et al*., the role of scapular dyskinesia on the glenohumeral was investigated. The exact role and function of the scapula can be understood in many clinical situations. This lack of awareness is often interpreted as an incomplete assessment and diagnosis of shoulder problems. In addition, shoulder rehabilitation is often overlooked. However, recent research has shown the pivotal role of the scapula in shoulder function, shoulder injury, and shoulder rehabilitation (32). Optimal shoulder function is an integral component of optimal shoulder function. Multiple roles of the scapula have been identified in arm function and throwing, while scapular dysfunction continues to be associated with various shoulder pathologies. Although scapular motion changes may be common in overhead athletes, various reports have shown that identification and change management can lead to improved rehabilitation and functional outcomes. Since arm throwing movements in swimming occur due to integrated, multipart, sequential joint movement and muscle activation in the kinetic chain, function and dysfunction in the kinetic chain must be understood. Additionally, the scapula is a key link in the chain through its function of maximizing scapular rhythm and efficient throwing mechanics (33).

Therefore, assessment and management starting with the shoulder can lead to improved outcomes associated with shoulder pathology in swimmers. Although rehabilitation programs follow principles, they must be individualized based on the patient's presentation and return-to-sport needs. This study discusses scapular dyskinesia as a functional disorder associated with throwing injuries and altered performance and the relevance of the diseases to develop appropriate treatment in the future. This knowledge helps doctors to take more comprehensive care of the athlete. The evidence has shown that with the corrective method of controlling people with symptoms of scapular dyskinesia, they have recovered their correct posture, which is accompanied by a decrease in pain and an increase in the range of motion in the shoulder girdle. Swimmer's shoulder is a condition that may be identified with proper pre-season screening to identify disorders and training errors that may lead to symptoms. Suppose the swimmer becomes symptomatic during the season. In that case, the health and pathology specialist should identify the most likely disorders or training errors and investigate any significant tissue pathology requiring referral to an orthopedist. A comprehensive rehabilitation program usually includes strengthening the rotator cuff and scapular stabilizers, stretching the pectoralis anterior muscles that may be shortened, and applying activity modifications so that the athlete can continue to participate in sports. Future research should focus on addressing specific injuries before the season can reduce the incidence of a swimmer's shoulder and evaluate which injuries are the most significant risk factors. The results of the present research showed a significant difference in the performance of the scapula between people with dyskinesia and healthy individuals. This finding suggests that coaches and professional athletes, by repeating and practicing extensively on one side, may inadvertently cause problems on the opposite side, which can significantly impact the athlete's performance. On the other hand, paying attention to the condition of the involved body part and correcting any dyskinesia before training, can be very effective in improving the athlete's performance. According to the research results, it is suggested to classify people with dyskinesia based on the disease before starting sports and the disease as a result of exercise and compare the performance of the scapula to those without dyskinesia.

CONCLUSIONS

Swimmer's shoulder is a musculoskeletal condition that results in symptoms in the area of the anterior lateral aspect of the shoulder, sometimes confined to the subacromial region. The onset of symptoms may be associated with impaired posture, glenohumeral joint mobility, neuromuscular control, or muscle performance. Additionally, training errors such as overuse, misuse, or abuse may also contribute to this condition. In extreme cases, patients with swimmer's shoulder may have soft tissue pathology of the rotator cuff, long head of the biceps, or glenoid labrum. Physical therapists involved in the treatment of competitive swimmers should focus on prevention and early treatment, addressing the impairments associated with this condition, and analyzing training methods. Considering the importance of injury risk factors, such as scapular dyskinesia, on movement patterns, it is necessary to consider the impact of this defect on swimmers to identify it as one of the risk factors as a target point for prevention. Prevent the risk of chronic injuries in these people.

FUNDINGS

The study was funded by Vice-chancellor for Research and Technology, Hamadan University of Medical Sciences (No. 140104282961).

DATA AVAILABILITY

Data are available under reasonable request to the corresponding author.

CONTRIBUTIONS

MK: study design. HN: data collection. HN, SHB: writing. HN: editing and revision. RNV: data analysis., MK: discussion section improvement.

ACKNOWLEDGMENTS

This article is extracted from research project 140104282961 of Hamadan University of Medical Sciences

CONFLICT OF INTERESTS

The authors declare that they have no conflict of interests.

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