Research Paper: Short-term and Long-term Effects of Kinesio-taping on Pain and Functional Stability in Swimmers With Shoulder Impingement Syndrome

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Citation Abshenas E, Karimizadeh Ardakani M, Shalamzari MH. Short-term and Long-term Effects of Kinesio-taping on Pain and Functional Stability in Swimmers With Shoulder Impingement Syndrome . Physical Treatments. 2021; 11(4):227-238. http://dx.doi.org/10.32598/ptj.11.3.443.2

http://dx.doi.org/10.32598/ptj.11.3.443.2

Article info:
Received: 10 Jun 2020
Accepted: 21 Feb 2021
Available Online: 01 Oct 2021

Keywords:
Kinesio Taping (KT), Pain, Functional stability, Shoulder impingement syndrome

ABSTRACT

Purpose: Kinesio-Taping (KT) is a new therapeutic approach for Shoulder Impingement Syndrome (SIS), which is common in swimmers. This study was performed to investigate the short- and long-term effects of KT on shoulder pain and functional stability in swimmers with SIS.

Methods: In this quasi-experimental study (randomized control trial), 28 swimmers with SIS were randomly allocated to the taping and control group. We used the Davis test and Upper Quarter Y-Balance Test (UQYBT) to assess the functional stability of the shoulder girdle and also the Visual Analog Scale (VAS) to assess pain. The data were gathered in three time points: pre-test, 20 minutes, and 72 hours after the procedure. For statistical analysis, we used repeated-measures analyses of variance with a significance level of $\alpha<0.05$. The analyses were done in SPSS.

Results: The results showed that the taping group had a significantly improved in Davis test and UQYBT in the follow-up and the post-test and also significantly improved in VAS in the post-test compared to the control group. Also, the mean scores of pain, UQYBT, and Davis tests in the follow-up were significantly improved. The mean scores of the UQYBT and Davis test in the post-test were significantly better than those in the pre-test in the taping group ($P=0.001$). However, there was no significant difference between any of the time points in the control group ($P<0.05$).

Conclusion: Given the results, KT can provide a basis for reducing pain and improving the functional stability of the shoulder girdle of swimmers with SIS. KT can be used as a complementary treatment technique in people with shoulder impingement syndrome and prevent possible injuries in the area.

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Highlights

- After Kinesio-taping, shoulder pain was less in the follow-up stage than in the pre-test and post-test stages.
- After 20 minutes of using kinesio-taping, functional stability in the shoulder joint of swimmers increased.
- Davis and upper-quarter Y balance test showed a signifcant improvement compared to the pre-test after taping.

Plain Language Summary

Shoulder pain and shoulder injury are very common in swimmers and the stability of this joint decreases following shoulder joint injury. One way to improve shoulder pain and condition is to tape and fix on the shoulder That kinesio-tape allows people to do that. The results of this study showed that shoulder pain and shoulder joint stability improve after shoulder taping. These results suggest that taping can provide the basis for reducing pain and improving the sability of swimmers' shoulder girdles. Therefore, inesio-tape can be used as an adjunctive treatment technique for people with Shoulder pain and prevent possible injuries in this area.

1. Introduction

Shoulder joint injury is one of the most common upper limb injuries [1]. The shoulder girdle consists of a series of joints with complex muscular ligamentous structures frequently used in daily activities and performing exercise skills [2, 3]. This range of activities is responsible for the prevalence of shoulder injuries in sports and can have various types of traumatic and especially micro-traumatic origin [4].

Most injuries in swimmers occur in the shoulder area [5]. A study of 80 swimmers reported that 91% of swimmers experience shoulder pain, and 81% had positive symptoms of Shoulder Impingement Syndrome (SIS) [5]. Supraspinatus muscle tendon and subacromial bursa, as well as the long head of biceps muscle, are the most common areas affected by SIS [6]. Possible causes of SIS are deformities of the subacromial arch, weakness or erosion of the rotator cuff muscles tendons, articular capsule stiffness, muscle imbalance, shoulder kinematics change, shoulder postural changes, altered motor coordination, and scapulohumeral rhythm of the arm [7, 8].

Numerous studies have reported a relationship between shoulder pain and shoulder instability, suggesting that impaired scapular and shoulder joint stability may be risk factors of SIS or shoulder pain that may lead to functional disorders, including decreased shoulder girdle stability [3, 5]. Shoulder girdle stability is crucial for optimal upper limb movement and maintaining shoulder girdle health. According to research conducted in this area, the findings suggest that SIS decreases stability and hypermobility in the shoulder region [9].

Different treatments, from conservative ones to injection and surgery, are recommended to control the clinical symptoms of SIS. Conservative treatments mostly include restoring natural kinematics and paying attention to the role of muscles in the subacromial space [10]. For the treatment of SIS in athletes, various treatments have been selected, including the administration of anti-inflammatory drugs, oral and intramuscular corticosteroids, joint filtration by subacromial injection method, ice therapy in acute cases after injury, effleurage and friction massage, immobilization of the injured limb, flexibility and strength exercises, movement therapy, ultrasound, and transcutaneous electrical nerve stimulation [11]. Various rehabilitation interventions such as strengthening, stretching, and motor control exercises positively affect SIS [12].

To investigate the effect of another treatment method for SIS, Ugur and Kul demonstrated that conventional Physical Therapy (PT) modalities could reduce pain and improve the physical movements and functions of patients with SIS [13]. In another study, Moslehi et al. showed that a rehabilitation program integrated with verbal feedbacks is effective in relieving pain and improve function and scapular kinematics in patients with SIS. Adding feedback to an exercise therapy could clinically enhance outcomes in patients with SIS [14]. Also, myofascial release can be used as an initial treatment for pain reduction among SIS individuals [15].

The treatment program should include improvement of the mechanical and sensory function of the articular structures and include proprioception exercises [16]. The use of Kinesio Taping (KT) as adjunctive therapy for SIS has been proposed [17]. It has been claimed that KT has many benefits, including increasing muscle strength [18], improving function [19], facilitating the onset of muscle contraction [20], increasing blood flow [21], reducing pain [22], correcting improper alignment and lifting of the skin, increasing subacromial space [23], and creating more space underneath the taped area [24]. Recent studies investigating the effect of KT in impingement syndrome individuals have concluded that reducing the pain, improving muscle strength, and increasing range of motion are the likely the result of KT [25]. Also, studies identified the positive effects of KT on scapular joint position sense and movement control [26].

Given the high prevalence of shoulder pain, especially SIS in swimmers, and the benefit of using KT by the patient out of the clinic compared to other modalities, as well as the contradicting results on the effect of KT, it seems wise to examine this treatment. According to the literature, KT can alter shoulder biomechanics and even be effective for shoulder injury [6]. This treatment does not have any adverse effects and supports the muscles and joints without restricting the range of motion. It contributes to the stability of the shoulder area, which can ultimately help the body's natural healing process. Therefore, the present study aimed to investigate the short- and long-term effects of KT on shoulder pain and functional stability of the shoulder in swimmers with SIS.

2. Materials and Methods

Study design

Forty-two swimmers with SIS were selected as potential participants, but seven failed to meet the inclusion criteria. Additionally, five participants withdrew from the study for personal reasons, and two could not return on day 3, leaving complete data on 28 participants.

The study subjects were randomly divided into two groups of control and taping (Table 1). Before starting the tests, a summary of the study procedure was explained to the subjects. All participants provided informed written consent before the experimental tasks, and all procedures were approved by the local Research Ethics Committee of Physical Education and Sport Sciences Faculty of the University of Tehran (reference number: IR.UT.SPORT.REC.1398.059).

The first step after completing the consent form was measuring and recording demographic information of the subjects (age, height, weight, shoulder instability) (Table 1). The inclusion criteria for patients with impingement syndrome were positive near impingement test, Hawkins-Kennedy impingement test, a painful touch of rotor cuff tendon, resistive abduction pain, a minimum VAS score of 3, with at least 6 months history of shoulder pain. All tests were performed by a corrective exercise expert [17]. The exclusion criteria were fracture in the shoulder joint complex, intra-articular steroid injection, glenohumeral dislocation or subluxation, shoulder girdle fracture, acromioclavicular sprain, history of a shoulder surgery within the previous 6 months, and using other treatments at the same time. If the participants could not perform the Davis test or Upper Quarter Y-Balance Test (UQYBT), they were excluded from the research process.

The treatment group received a standardized therapeutic KT utilization (Figure 1). The general instructions were the same as the protocol for rotator cuff tendonitis/impingement suggested by Kase [27]. Standard 5-cm black Kinesio Tex tape was used for all applications in the taping groups. The first strip, which was applied from its insertion to origin with paper-off tension, was a "Y" strip representative of the supraspinatus. A "Y" strip refers to a section of tape with a portion cut down the middle to produce 2 tails. Paper-off tension means sticking the tape directly to the skin as it comes off the paper backing [27]. The first strip was applied to the treatment group subjects in a position with lateral neck flexion to the opposite side and the arm reaching behind the back as if reaching into the contralateral back pocket. The second strip was a "Y" representative of the deltoid, also applied from insertion to origin with paper-off tension.

The second strip was applied with the first tail to the anterior deltoid while the arm was externally rotated and horizontally extended. The tail for the posterior deltoid was applied with the arm horizontally flexed and internally rotated as if reaching to the outside of the contralateral hip. Both first and second strips were applied with light tension (15%-25% of available) or paper-off tension to the Kinesio "Y" strip. The third strip, approximately 20 cm in length, was an "I" strip (with no cut down the middle of the tape). It was applied from the region of the coracoid process around to the posterior deltoid with a mechanical correction, approximately 50% to 75% (moderate to severe tension) stretch, and downward pressure applied to the KT at the region of perceived pain or tenderness. The mechanical correction technique was applied with the upper extremity externally rotated while at the side. The upper extremity was

then moved into shoulder flexion, and slight horizontal flexion as the end of the tape was applied with no stretch [27, 28]. All the test procedures were repeated after attaching the KT strip.

Davis test and UQYBT

These tests were used to investigate upper body stability. To evaluate the Davis test, two strips 90 cm apart were stuck on the ground, and the subjects were asked to position each arm on a strip, take push up position, and then touch the left strip with the right hand and the left strip with the right hand for 15 seconds with the highest speed (Figure 2). The number of times the strips were touched in 15 seconds was recorded as an individual score. The subjects performed this test three times, and the average of three attempts was recorded as their record [29].

Results suggest that the Davis test is a reliable tool to evaluate upper extremity functional performance for males and females with SIS [30]. Davis test was applied to subjects with other shoulder dysfunctions [31]. The intersession reliability of the Davis test for SIS samples showed an excellent intraclass correlation coefficient (ICC>0.75) [30].

A Y-balance plate test measure was used to perform the test, which was attached to graded bars in three directions, with a movable indicator on each bar. It specified the reach on the direction by moving the indicator with the free hand. To perform this test, we asked the subject to start on the palms and toes (without shoes) as shown in Figure 3 and maintain the spine and lower limbs along. The shoulder with SIS was selected as the support. The thumb was pre-positioned by a straight line, and the legs were shoulder-width apart. In this position, the subject was asked to maintain the support arm position while trying to reach the body and lower limbs with the free hand in the three directions of medial reach, superolateral, and inferolateral (as shown) as far as possible. To compare with other subjects, the values of upper extremity access (the distance between the seventh cervical vertebra to the end of the longest finger at 90 degrees of shoulder abduction and elbow, wrist, and toe extension) were normalized [32]. Access was performed in all three directions in a row, without rest and touching the ground with the free hand. The subject was allowed to rest the free hand on the ground and relax after each round (reaching in 3 directions), and perform this procedure for 3 rounds [33]. Before the test, each person was allowed to perform the test one time. To prevent bias in the recording of the results, the second tester, who was unaware of the condition of the subjects' shoulder condition, recorded the reach. In each direction, the highest achievement was recorded and placed in the following formula to calculate the overall composite score:

[(Medial reach+superolateral access+inferolateral access)÷3]×limb length= composite score

In addition, to compare scores of different directions separately, these scores were normalized with upper limb length, and the normalized score for each direction was compared. Inter-rater reliability (r=0.99 to r=0.80) and intra-rater reliability (r=1.00) of this test have been reported excellent [33, 34].

Visual Analog Scale (VAS) was used to measure shoulder pain. This scale is the most valid pain rating for comparing different time points and has been reported to have high validity and internal reliability (ICC=0.91) [35, 36]. Using this scale, the subjects would rate their pain on a 10-cm long continuum (ranging from 0 pain free to the 10 most severe possible pain). All tests were performed in three stages: 1) pre-test, 2) post-test to assess the acute effect that occurred 20 minutes after taping, and 3) follow-up, which was performed 72 hours after taping. All evaluations were performed in the Corrective Exercise Laboratory of the Faculty of Physical Education and Sport Sciences of Tehran University.

For statistical analysis of data, repeated-measures Analyses of Variance (ANOVA) was used to compare time-dependent variables, within-group variations, and group interaction×time. Also, the Bonferroni post hoc test was used to investigate differences between different stages of research in each group. This test was set with an alpha error of 0.01.

3. Results

Table 1 presents the Mean±SD of the individual characteristics of the subjects. The homogeneity of the study groups was checked before the intervention by the independent t test, and results have shown that groups were matched in all dependent variables (Table 2). The normal distribution of data was performed by the Shapiro-Wilk test at all stages of the study, indicating a normal distribution of data in both groups, and there was no significant difference between the two groups in the pre-test (Table 3). The statistical analysis results performed by repeated-measures Analyses of Variance (ANOVA) in comparing time-dependent variables, intergroup variations, and time×group interaction are presented in Table 2. Then, to investigate the differences between different time points in each group, the Bonferroni post hoc test

PHYSICAL TREATMENTS

Figure 1. Placement method of the kinesio taping

Figure 2. Davis test PHYSICAL TREATMENTS

was used. In this test, the alpha error was set at 0.01. The results showed that the mean score of pain in the follow-up test was significantly better than the post-test and the pre-test in the taping group (P=0.001), but there was no significant difference between the post-test and the pre-test (P=0.120). However, there was no significant difference between any of the time points in the control group (P<0.05) (Table 4).

An examination of shoulder functional stability by the Davis and upper-quarter tests showed that after taping, both trials showed a significant improvement compared to the pre-test (P<0.05). In addition, this difference between the follow-up and the post-test was significant in that the taping group and yielded better results in the follow-up (P <0.05) (Table 4). In all four components of medial, superolateral, inferolateral reach, and a composite score of Y test, the results were similar during the time variables, and the subjects in the taping group showed a significant improvement compared to the post-test and the pre-test (P<0.05). Similarly, this improvement was observed in the post-test compared to the pre-test, but in the control group, there was no significant change between the study time points (P<0.05). The results of the independent t test are reported in Table 3.

4. Discussion

This study aimed to evaluate the short- and long-term effects of KT on pain and functional stability in swimmers with SIS. The results showed that after 20 minutes of using KT, functional stability in the shoulder joint of swimmers increased. The improvement continued for 72 hours after the tape application, and the subjects in the taping group improved in the post-test (acute effect). The results also showed that the subjects in the taping group had significantly lower pain in the follow-up compared to the post-test and pre-test.

Concerning the reduction in pain after using KT, the results of Bhashyam et al. [22] and Dhein et al. [6] were in line with the results of the present study. In the Chao et al. study, 15 subjects received just manual pressure release, and 16 subjects received manual pressure release in combination with taping (MPR/MKT) [37]. The results showed that the pressure pain threshold improved significantly in both groups, but MPR/MKT has a greater effect on muscle stiffness and contraction amplitude. Mariana et al. [38] found that massage and KT both significantly reduce pain and neck disability, but the patients benefiting from KT recorded a more rapid reduction of pain. The results of Ay et al. [24] were similar to this study, indicating that the use of KT reduces pain. Kaya et al. [17] concluded in their study that KT is more effective than the local modalities in the first week and was similarly effective at the second week of the treatment. Kinesio-taping may be an alternative treatment option in treating shoulder impingement syndrome, especially when an immediate effect is the goal.

Figure 3. Upper Quarter Y-Balance Test (UQYBT) PHYSICAL TREATMENTS

Table 1. Participant's characteristics at baseline

Variables	Mean±SD		Sig.
	Taping Group (n=12)	Control Group (n=12)	
Age (y)	25.86±1.40	25.93±1.43	0.895
Height (cm)	177.71±3.07	177.14±2.82	0.616
Weight (kg)	71.64±3.01	70.86±3.41	0.530
Body mass index (kg/m^2)	22.69±1.03	22.57±0.81	0.740
Upper limb length (cm)	88.85±1.53	88.57±1.43	0.616

PHYSICAL TREATMENTS

According to the literature, no research has been done on the long-term effect of KT on performance and its comparison with immediate effect. The present study results showed that in addition to the immediate effect of KT, it was more effective in improving the function and pain of people with SIS.

Various theories have been proposed to explain the mechanism of KT, including increased proprioception, stimulation of the area and receptors of the skin, improvement of blood and lymph circulation, reduction of pain severity, improvement of articular alignment, postural alignment assist, and muscle relaxation [24]. However, the precise mechanism is not yet fully understood. There are hypotheses about the possible analgesic effect of the KT, and the "gate control theory of pain" seems to be the most basic approach. The gate control mechanism states that increased sensory inputs to the skin that reach the central nervous system lead to pain relief [24, 39]. In other words, KT creates more space between the medial membrane of the skin and the muscle by drawing the upper layers of the skin. This created space reduces the pressure on the lymph channels in the area between the muscle and the medial membrane of the skin and creates more space for the lymph to flow better to the affected area. It also contains various neural receptors that send specific information to the brain. When the space between the epidermis and the muscles is pressed, as in an injury, the nerve receptors are also pressured and send information about the continuous touch, light touch, cold, pain, pressure, and heat to the brain. This information causes the brain to send specific signals to the body to respond to specific stimuli. The KT modulates the information these receptors send to the brain and causes less responsive responses in the body [24, 39, 40]. In other words, KT, if used correctly, leads to superficial stimulation of cutaneous sensory afferent and inhibits pain transmission at the spinal cord surface, and reduces pain [41].

Table 2. Comparing time-dependent variables and intergroup variations and group×time interaction

Variables		Group		Time		Group×Time	
		Sig.	Effect Size	Sig.$^+$	Effect Size	Sig.*	Effect Size
	VAS	0.037‡	0.158	0.001	0.534	0.001	0.528
	Davis	0.003‡	0.298	0.001	0.787	0.001	0.671
UQYBT	MR (cm)	0.317	0.039	0.001	0.362	0.001	0.344
	SLR (cm)	0.204	0.061	0.001	0.682	0.001	0.615
	ILR (cm)	0.312	0.039	0.012	0.173	0.002	0.248
	CS	0.143	0.081	0.001	0.533	0.001	0.545

PHYSICAL TREATMENTS

$^+$Significant time effect (P<0.05); * Significant (P<0.05) interaction effects (group×time); ‡ significant difference between the taping and control group (P<0.05).

UQYBT: Upper Quarter Y-Balance Test; MR: Medial Reach; SLR: Superolateral Reach; ILR: Inferolateral Reach; CS: Composite Score; VAS: Visual Analog Scale.

Table 3. Independent t test information in all three stages of research

Variables		Time	Mean±SD		Sig.*
			Taping Group	Control Group	
	VAS	Pre-test	4.57±1.16	4.64±1.08	0.867
		Post-test	4.28±1.50	4.85±1.15	0.214
		Follow-up	2.50±1.40	4.71±1.32	0.001*
	Davis	Pre-test	20.95±1.28	20.61±1.28	0.499
		Post-test	21.66±1.25	20.56±1.44	0.041*
		Follow-up	24.33±1.50	21.06±1.15	0.001*
UQYBT	MR (cm)	Pre-test	1.02±0.04	1.02±0.04	0.994
		Post-test	1.04±0.04	1.03±0.05	0.519
		Follow-up	1.07±0.04	1.03±0.04	0.027*
	SLR (cm)	Pre-test	0.74±0.04	0.74±0.02	0.934
		Post-test	0.76±0.04	0.75±0.03	0.359
		Follow-up	0.78±0.03	0.75±0.03	0.007*
	ILR (cm)	Pre-test	0.84±0.03	0.85±0.03	0.580
		Post-test	0.85±0.03	0.85±0.03	0.697
		Follow-up	0.88±0.04	0.85±0.04	0.014*
	CS	Pre-test	0.87±0.03	0.87±0.02	0.833
		Post-test	0.88±0.03	0.87±0.03	0.389
		Follow-up	0.91±0.03	0.87±0.02	0.001*

PHYSICAL TREATMENTS

* Indicates a significant difference between the experimental and control group collapsed means (P<0.05).

UQYBT: Upper Quarter Y-Balance Test; MR: Medial Reach; SLR: Superolateral Reach; ILR: Inferolateral Reach; CS: Composite Score; VAS: Visual Analog Scale.

According to our study results and others, the symptoms improvement after using KT may be due to the increase in the awareness of movement and correction of joint arthritis alignment and the stimuli caused by the stretching of the KT [42]. This process allows the body to operate in a more natural way and removes some of the barriers that slow down the healing process [43, 44]. Subsequently, with decreasing pain, the desire for hand use in activities is increased, which in turn influences grip strength and range of motion [42]. Lee and Choi showed that combining two techniques of balance taping and cross taping after 3 weeks (16 hours per day) decreased the VAS pain score from 7 to 0, in addition to an increasing range of motion. They found that combining these two KT techniques is effective as a treatment for people with SIS [45]. In another study conducted in 2019 on 105 patients with SIS, the researchers found that KT reduced pain. In this study, both VAS and the Disabilities of the Arm, Shoulder and Hand (DASH) scores were significantly reduced [46], which is in line with our results.

The positive effect of KT on kinematic patterns has already been proven. For instance, KT could be effective in returning the scapula into the correct motion pattern in people with SIS who experience a reduction in scapular posterior tilt [47]. Using KT in SIS individuals may improve the optimal rhythm and motion pattern of the glenohumeral joint and maintain the correct scapula alignment during movements. Muscle performance and muscle recruitment patterns improve due to this align-

Table 4. Result of Bonferroni test for different groups and time points

Variables	Groups	Time		Mean Difference	Sig.*
VAS	Control	Pre-test	Post-test	-0.214	0.247
			Follow-up	-0.071	1.000
		Post-test	Follow-up	0.143	1.000
	Taping	Pre-test	Post-test	0.286	0.120
			Follow-up	2.071	0.001*
		Post-test	Follow-up	1.786	0.001*
Davis	Control	Pre-test	Post-test	0.051	1.000
			Follow-up	-0.448	0.162
		Post-test	Follow-up	-0.449	0.094
	Taping	Pre-test	Post-test	-0.712	0.001*
			Follow-up	-3.380	0.001*
		Post-test	Follow-up	-2.668	0.001*
CS	Control	Pre-test	Post-test	0.001*	1.000
			Follow-up	0.001*	1.000
		Post-test	Follow-up	-0.001	1.000
	Taping	Pre-test	Post-test	-0.10	0.001*
			Follow-up	-0.038	0.001*
		Post-test	Follow-up	-0.028	0.001*

* Indicates a significant difference between time points (P<0.05).
CS: Composite Score; VAS: Visual Analog Scale.

PHYSICAL TREATMENTS

ment correction; therefore, the performance of muscles modifies as in force couple relationships and length-tension relationships, which can result in pain reduction and stability in the shoulder girdle [29]. KT can probably make the muscular activity more efficient through a supporting effect and influence the employment of correct muscular cooperation [47]. So using KT could probably play an influential role in improving muscle balance through creating correct alignment and muscular support.

Dysfunction of the stabilizer component of the joints leads to mechanical instability resulting in impairing the sensory-motor system and shoulder proprioception [48]. With the development of these disorders, movement patterns that must act on the precise feedback of sensory receptors cannot manage the coordinated pattern of muscle contraction, thereby leading to functional instability of the joint [48, 49]. Previous studies have also suggested that pain reduction may be a

contributing factor to the shoulder joint position sense, which also results in using KT to reduce shoulder pain in the subjects [16]. Therefore, by enhancing the proprioception of movement patterns that should reveal better performance according to the sensory receptors' precise feedbacks, the resulting co-contraction pattern of the muscles is better managed by the sensory-motor system and ultimately improve functional stability.

5. Conclusion

According to the study results, the use of KT in the shoulder joint can significantly improve the functional stability of the shoulder joint 20 minutes and 72 hours after taping. It also significantly reduces the pain score after 72 hours. These results suggest that taping can provide the basis for reducing pain and improving the functional stability of swimmers' shoulder girdles. Therefore, KT can be used as an adjunctive treatment technique for people with SIS and prevent possible injuries in this area. One of the limitations of this study was using the male gender, so it is suggested to involve females in future studies. Another limitation of this study was the shortness of the time between baseline and follow-up, which can be investigated in longer time duration and more frequently in further research.

Ethical Considerations

Compliance with ethical guidelines

All ethical principles were observed in this research. The participants were informed about the research purpose and its procedure. They were also assured about the confidentiality of their information. Finally, they were free to leave the study whenever they wished, and if desired, the research results would be available to them. This study was approved by the Ethics Committee of the Department of Health and Sports Medicine of Tehran University of Medical Sciences (Code: IR.UT.SPORT.REC.1398.059).

Funding

This research was supported by the research project, Funded by the University of Tehran (No.: 30938/5).

Authors' contributions

All authors equally contributed to preparing this article.

Conflict of interest

The authors declared no conflict of interest.

Acknowledgments

The authors would like to thank all the study participants and appreciate the sincere cooperation of the Vice-Chancellor of Research at the University of Tehran.

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