

Upper Extremity Function And Injury Prediction Tests In Crossfit Athletes With And Without Scapular Dyskinesia

Donya Asgari, Mojtaba Ebrahimi Varkiani, Sabikeh Moghaddam Nezhad,
Sara Matinfard

(Department Of Sport Sciences / University Of Tehran, Iran)

(Department Of Sport Sciences / University Of Tehran, Iran)

(Department Of Sport Sciences, East Tehran Branch, Islamic Azad University, Iran)

(Department Of Sport Sciences / Shahid Behest University, Iran)

Abstract:

Background: The scapula is an essential part of the shoulder girdle, enabling movement, transferring loads, and ensuring functional coordination between the upper limbs and the axial skeleton. Scapular asymmetry and dyskinesia—abnormalities in positioning and movement—can disrupt upper extremity biomechanics, especially among athletes. This study aimed to compare upper extremity function and Functional Movement Screen (FMS) performance in athletes of CrossFit with and without scapular dyskinesia.

Materials and Methods: A total of sixty male CrossFit participants were evaluated using the Nordic Musculoskeletal Questionnaire alongside the Disabilities of the Arm, Shoulder, and Hand (DASH) instrument, the Davis test, the Lower Scapular Spine to Thorax (LSST) test. Additionally, participants underwent assessment using the Y-Balance Test in conjunction with the Functional Movement Screen (FMS). Based on clinical assessment, participants were classified into two groups with or without scapular dyskinesia.

Results: The Shapiro-Wilk test indicated that the data were not normally distributed ($p = 0.000$). Subsequent Mann-Whitney U tests showed no statistically significant differences between the groups for Y-Balance Test scores (left: $p = 0.416$; right: $p = 0.404$), Davis test results ($p = 0.341$), DASH scores ($p = 0.651$), or FMS scores ($p = 0.3$). No significant differences were observed between right and left limb balance scores ($p=0.42$; and $p=0.28$, respectively).

Conclusion: The results indicate that the diverse and functional movement characteristic of CrossFit might reduce the effects of scapular dyskinesia. Although some athletes had scapular asymmetry, there were no significant differences in upper limb function, balance, or perceived disability compared to those without the condition. This indicates that consistent CrossFit training may support shoulder stability and overall performance, even in the presence of scapular dysfunction.

Key Word: CrossFit; Scapular Asymmetry; Davis Test; Disabilities of the Arm; Shoulder and Hand questionnaire.

Date of Submission: 21-10-2025

Date of Acceptance: 31-10-2025

I. Introduction

CrossFit is appealing to both physically active individuals and those with sedentary lifestyles. A sedentary lifestyle prior to engaging in a CrossFit program has been noted as a potential risk factor for increased injuries (1). One of these conditions is scapular dyskinesia, which is commonly seen in athletes with upper extremity overload.

Scapular dyskinesia is defined as dynamic alterations in the position of the scapula relative to the thorax, leading to imbalances in the scapulohumeral rhythm. This condition usually arises as a result of several factors, including muscle fatigue, neuromuscular disorders, intra-articular shoulder problems, or subacromial issues (2). Scapular dyskinesia can be observed in many athletes, especially those performing overhead movements, such as CrossFit athletes. Research indicates that scapular dyskinesia is not just a result of shoulder injuries but can also act as a contributing factor, especially because of the increased strain on the shoulder girdle muscles and restrictions in shoulder strength and range of motion (3). Research indicates that scapular dyskinesia may occur in roughly 67% to 100% of athletes with shoulder injuries, and it can also be observed in individuals without symptoms (4). This highlights the importance of examining scapular dyskinesia as a predictor of shoulder injuries (5). Abnormal scapular mechanics can increase stress on shoulder structures and create imbalances within the joint. Especially in athletes requiring repetitive and heavy overhead movements,

such as CrossFit athletes, scapular dyskinesia can directly lead to weaknesses in the shoulder girdle and more serious injuries (6).

A total of 553 shoulder injuries have been reported across included studies, indicating that these injuries make up between 6.7% and 40.6% of all injuries. A lifetime prevalence of shoulder injuries of 36.4% was reported in a study by Hak et al. Prevalence over a six to twelve-month period ranged from 5.4% to 26.4%. Prospective studies reported an incidence rate of shoulder injuries between 9% and 11.5%. Retrospective studies reported an incidence rate of between 16.7% and 36.9% for shoulder injuries (7).

It is worth noting the significant and growing interest among researchers and the general public in high-intensity physical activities. Studies show that high-intensity training, compared to traditional training methods, offers greater benefits for fitness and health in less time (8).

CrossFit has emerged as a contemporary form of physical activity that has gained widespread popularity since its introduction in the early 2000s. Its primary goal is to enhance overall fitness by targeting multiple components—including aerobic capacity, strength, muscular endurance, speed, coordination, agility, and balance—through functional training modalities such as weightlifting, gymnastics, and aerobic conditioning (9).

Studies show that CrossFit has a significant impact on promoting athletic performance. The method's use of multiple and diverse exercises improves the overall fitness of athletes (10). In particular, due to its intense workouts and short rest periods, CrossFit can help increase aerobic capacity and explosive muscular power. Weight training, which is part of CrossFit, helps improve muscle strength and neuromuscular coordination (11).

Worldwide, there are approximately 12,000 verified and registered fitness centers and gyms offering CrossFit. Of these, roughly 440 are in Brazil, involving approximately 40,000 practitioners and athletes (11).

The American College of Sports Medicine (ACSM) recognizes several potential benefits of CrossFit while also emphasizing the considerable injury risks associated with its high-intensity training programs. These risks stem from performing certain exercises incorrectly or excessively, which may result in musculoskeletal injuries or ligament damage. Consequently, there is increasing concern about injuries linked to the repetitive and demanding nature of CrossFit, as well as the technical proficiency required for safe execution, both in university settings and training facilities.

Scapular dyskinesia is recognized as dynamic changes in scapular movement and position, which can lead to imbalances in the rhythm of movement between the shoulder and thorax. These imbalances, especially in sports that require rapid and repetitive upper extremity movements like CrossFit, can lead to reduced athletic performance and increased risk of injury. Studying athletes with and without scapular dyskinesia provides an opportunity to explore these differences and identify risk factors. Additionally, scientific studies in the area of upper extremity function and injury prediction tests in CrossFit athletes with and without scapular dyskinesia will provide practical evidence to coaches, physiotherapists, and athletes, enabling them to develop appropriate prevention and treatment strategies. This research will not only help improve athletes' health and performance but also reduce treatment costs and extend athletes' careers. Therefore, gathering information from existing literature on injuries in CrossFit practitioners allows us to familiarize ourselves with data on prevalence and injury rates based on training hours, the most frequently injured areas of the body, and injury-related factors with the goal of developing and implementing more comprehensive training practices. Thus, the present study aims to investigate the prevalence of scapular dyskinesia, upper extremity function, and injury prediction tests in CrossFit athletes with and without scapular dyskinesia.

II. Material And Methods

To conduct the study, initial requests for collaboration were sent to CrossFit gyms. Then, 60 CrossFit athletes with more than 1 year of CrossFit training who were willing to participate were given the Nordic questionnaire and an initial demographic questionnaire. Based on the information provided in the questionnaire, 32 CrossFit athletes without acute injuries in the past 6 months and without head or neck pain were included in the testing phase. Functional movement screening tests, the Davis test, and the upper extremity Y-Balance test were administered.

The study population consisted of CrossFit athletes with more than one year of training experience in Tehran. A total of 100 CrossFit athletes were evaluated for scapular and shoulder status. The sample size of 32 athletes was selected using G Power software, with an alpha level of 0.05, a power of 0.8, and an effect size of 0.7. The prevalence of the abnormality was identified, and the relevant groups were chosen.

Inclusion criteria:

1. History of CrossFit training exceeding one year
2. No history of surgery in the neck and shoulder area
3. No pain in the shoulder and neck

4. No acute or chronic injury in the shoulder and neck
5. No specific conditions such as Multiple Sclerosis (MS)

Exclusion criteria:

1. Refusal to participate in the testing phase, unwillingness to use the analyzed test information for research purposes.
2. Incomplete information
3. Withdrawal during testing.
4. Experiencing pain during the test.

Data Collection Tools

Y-Balance Test for the Upper Extremity: In this test, the individual holds a plank position on one hand and reaches as far as possible with the other hand in three directions: medial, inferolateral, and superolateral. Feet are shoulder-width apart, and the body is aligned. The individual is allowed two practice trials, and the greatest distance reached on each side is recorded (1).

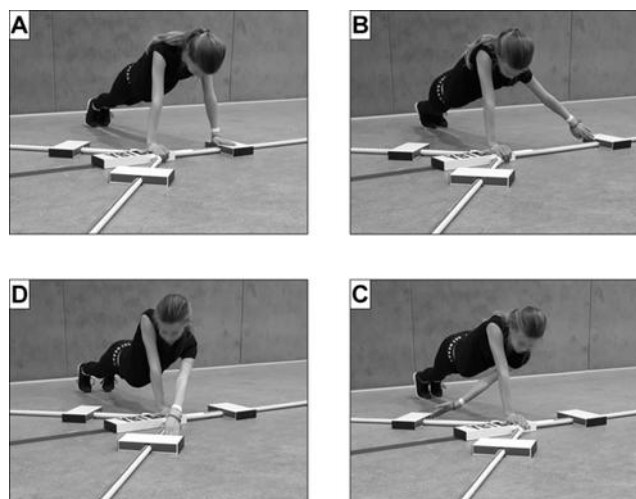


Figure 1. Y-Balance Test for the Upper Extremity

Davis Test: Test is a closed kinetic chain upper extremity stability test that provides quantitative data. For this test, two strips of tape are placed 90 centimeters apart on the ground. The individual places each hand on a strip and performs a push-up position, then quickly touches the opposite strip with one hand for 15 seconds. There is a 45-second rest between each repetition (12). Requirements: a straight back, knees not touching the ground, and maintaining an upright torso.



Figure 2. Davis Test

Data Collection Procedure

After selecting the desired gyms, a specific number of participants were evaluated, and the necessary information was collected. The required groups were then categorized based on the evaluation results, and the relevant tests were performed on each group. Finally, the results were analyzed using SPSS version 21. The Mann-Whitney U test and Shapiro-Wilk test were used for statistical analysis at a significant level of $p < 0.05$. For the purposes of the research, ethics approval was obtained from the University of Tehran's research committee under the number IR.UT.SPORT.REC.1403.031.

III. Result

Table no 1 Descriptive Findings

This table presents descriptive statistics for the study participants, separated into two groups: those with scapular asymmetry (experimental group) and those with scapular symmetry (control group). The data includes sample size, age, height, weight, and scores on the Functional Movement Screen (FMS) and Y-Balance Test (Y-Balance right and Y-Balance left).

Table no 1: Descriptive Findings

Variable	Experimental Group (Scapular Asymmetry)	Control Group (Scapular Symmetry)
Sample Size (n)	23	37
Age (years)	27.39 ± 6.94	30.51 ± 8.12
Height (cm)	179.28 ± 11.53	181.75 ± 9.21
Weight (kg)	84.30 ± 12.77	81.70 ± 11.39
FMS	17.17 ± 2.93	17.46 ± 1.85
Y-Balance Right	75.34 ± 27.03	91.81 ± 28.19
Y-Balance Left	76.82 ± 28.98	91.97 ± 27.79

- Data are presented as mean ± standard deviation.
- The Shapiro-Wilk test was conducted to assess data normality, which indicated that the distribution was not normal.

Table no 2 Results of the Mann-Whitney U Test for FMS Scores

This table shows the results of the Mann-Whitney U test, comparing FMS scores between the two groups. It also indicates whether there is a significant difference between the groups.

Table no2: Results of the Mann-Whitney U Test for FMS Scores.

Test	Mann-Whitney U	Wilcoxon W	Z	P
FMS	359	635	-1.02	0.3

The Mann-Whitney U test revealed no significant difference in FMS scores between the groups ($p = 0.3$).

Table no 3: Range of Motion Data

This table presents the range of motion data for the experimental group with scapular asymmetry, including the mean, and total scores for the Y-Balance test on the left and right, Davis Test and DASH test.

Table no 3: Range of Motion Data

Test	No Scapular Asymmetry	Number	Mean Domains	Total Domains
Y-Balance Left	0.00	22	18.25	401.50
Y-Balance Left	1.00	16	21.22	339.50
Total Y-Balance Left	-	38	-	-
Y-Balance Right	0.00	22	18.18	400.00
Y-Balance Right	1.00	16	21.31	341.00
Total Y-Balance Right	-	38	-	-
Davis Test	0.00	22	21.00	462.00
Davis Test	1.00	16	17.44	279.00
Total Davis Test	-	38	-	-
DASH Test	0.00	22	20.20	444.50
DASH Test	0.6	14	18.53	296.50
Total DASH Test	-	38	-	-

Table no 4 Results of Mann-Whitney U Test for Various Measures

This table presents the results of the Mann-Whitney U test, comparing various measures (DASH, Davis, Y-Balance Right, and Y-Balance Left) between the two groups of participants. It shows the U statistic, the Wilcoxon W statistic, the Z score, the Asymptotic Significance, and Exact Significance.

Table no 4 Results of Mann-Whitney U Test for Various Measures

Statistical Test	DASH	Davis	Y-Balance Right	Y-Balance Left
Mann-Whitney U	160.500	143.000	147.000	146.500
Wilcoxon W	297.5000	279.000	400.000	401.500
Z	05.511	0.982	0.858	0.814
Asymp. Sig. (2-tailed)	0.609	0.326	0.391	0.416
Exact Sig. [2*(1-tailed Sig.)]	0.651	0.341	0.404	0.421

The Mann-Whitney U test indicated no significant differences between the groups for the DASH ($p = 0.651$) and Davis ($p = 0.342$) tests.

Table no 5: Prevalence of Skeletal Pain and Affected Areas

This table shows the prevalence of skeletal pain and the areas affected among male CrossFit athletes. It should be noted that this table is not directly related to the study's main variables of scapular dyskinesia and should be excluded.

Table no 5 Prevalence of Skeletal Pain and Affected Areas

Affected Area	Number of Injuries
Shoulder	22
Lower Back	10
Knee	10
Elbow	9
Wrist	8
Ankle	5

• It appears that this table shows the distribution of injuries across different body parts in a sample of male CrossFit athletes. It is important to note that this table does not belong to the main study focus on scapular asymmetry and FMS scores and should be excluded

IV. Discussion

The scapula is a key component of the shoulder girdle, enabling movement, function, and force transfer from the arms to the trunk. Scapular asymmetry and dyskinesia are positional abnormalities of the scapula that can affect the quality of upper extremity function. This common condition is observed in athletes; therefore, the present study aimed to compare upper extremity function and FMS scores in CrossFit athletes with and without scapular dyskinesia.

The position of the scapula is significant for maintaining muscular balance in the upper extremity and trunk. After retraction, the scapula returns to its original position, which provides support for the rotator cuff muscles. This mechanism is bidirectional, as when the scapula is protracted, the positioning inhibits these muscles from achieving their full strength, thus limiting their ability to externally rotate with maximum force (13). Therefore, scapular asymmetry may affect shoulder girdles and scapular stability. This is consistent with the fact that the primary function of the rotator cuff muscles is to stabilize the shoulder joint by drawing the head of the humerus into the glenohumeral joint (14). In a study by Escamilla et al. (2009), it was reported that the supraspinatus and infraspinatus muscles play a key role in maintaining scapular position, causing a 45–55-degree scapular rotation during full range of motion of humeral abduction (15). Consequently, optimal function of these muscles plays a critical role in establishing stability in the shoulder joint.

In a study by Abshnas et al. (2020), which investigated functional stability and shoulder balance in students with and without scapular asymmetry, it was demonstrated that scapular asymmetry could result in alterations in the functional stability and balance of the shoulder girdle. These changes could potentially increase the risk of future shoulder injuries (16). Kim's study (2017) noted that scapular asymmetry could lead to inhibition and weakness in the activation of the middle trapezius (17). However, this study reported that there were no differences in execution during horizontal abduction and flexion, which are also used in the Y-Balance test. These movements require the middle trapezius to stabilize the scapula.

The difference in findings between previous studies and the present study may be due to the fact that CrossFit workouts require coordinated execution of movements involving multiple upper extremity joints,

which can strengthen weak areas or lead to adaptations to deficits within those muscles. Thus, based on the analyses concerning the disruption of coordination and balance among the muscles around the scapula and shoulder girdle due to scapular asymmetry, it appears that this specific sport may help mitigate or compensate for the issues caused by scapular asymmetry. Alizadeh et al. (2009) also demonstrated that exercise can improve the positioning of the scapula in protraction, which aligns with the present study's findings (18). Furthermore, in a study of 19 athletes across various sports, it was found that there was no difference in isometric and isokinetic strength or shoulder proprioception during abduction and adduction movements in people with and without scapular asymmetry, but differences were only observed in flexibility in shoulder internal and external rotation (19).

It is worth noting that this does not imply ignoring the need to correct existing misalignments but rather suggests that this particular type of activity reduces limitations and movement impairments. This sport may not directly correct scapular asymmetry or postural abnormalities, but it can likely improve performance and the quality of movement. This difference stems from the fact that previous studies involved non-athlete subjects. However, different results were observed when examining this in athletes. However, it has not been examined whether individuals beginning CrossFit develop scapular asymmetry, or whether they already had the asymmetry, and CrossFit did not cause the condition. It is recommended that future studies investigate this issue.

Additionally, the present study examined FMS scores and shoulder girdle stability as determinants of injury risk in CrossFit athletes with and without scapular symmetry. The results showed no significant differences in FMS scores and the right and left Y-Balance tests between CrossFit athletes with and without scapular asymmetry.

The alignment of the spine and the natural positioning of the scapula play a critical role in shoulder girdle function. This relationship is influenced by at least two key factors: during arm movements, the scapula serves as a stable base for glenohumeral joint motion while simultaneously moving in coordination with the arm throughout its range of motion. Alterations in scapular or shoulder positioning are linked to imbalances in the rotator cuff muscles and scapular stabilizers. Additionally, the alignment of the bony segments of the spine, scapula, clavicle, and humerus can be directly affected through their muscular attachments. Scapular asymmetry may result in changes in range of motion, proprioception, and muscular balance. Such imbalances can arise subtly due to altered proprioceptive input or abnormal joint posture and movement, leading to muscle shortening (hypertonicity) or weakness (inhibition). These localized muscular imbalances, combined with skeletal misalignment, can influence muscle length and impair a muscle's capacity to generate tension, ultimately reducing functional performance (13).

Movements performed in CrossFit are technically complex (20). These exercises require the capacity of the neuromuscular system to generate a series of high-intensity muscle contractions (21). Moreover, CrossFit athletes need sufficient upper extremity flexibility for movement phases requiring a high range of motion (22). Shoulder girdle injuries also occur due to the technical execution of exercises that require a high range of motion and stability of the joint complex. The biomechanical advantages activated by an optimal range of motion, which exists in CrossFit workouts, result in reduced stress and joint loading during movement, thereby minimizing adverse changes in joint tissues seen in overhead athletes (23). Consequently, the biological capacity of joint tissue remains constant.

The present study found no significant differences in FMS scores or shoulder girdle stability between CrossFit athletes with and without scapular asymmetry; however, the group with scapular asymmetry exhibited slightly lower FMS scores and shoulder girdle stability. These findings suggest that scapular asymmetry does not appear to influence muscle activity or the generation of shoulder girdle stability, as the muscle activation patterns were similar in athletes regardless of scapular symmetry. Additionally, no significant differences were observed between the groups in terms of predicted injury risk.

Based on these findings, scapular asymmetry may not affect the intensity of shoulder girdle muscle contractions in these athletes. In line with this, Akinoglu et al (2020) concluded that there was no significant difference in strength and shoulder proprioception between athletes with and without scapular symmetry, which is consistent with the results of the current study (19). In addition, an investigation by Turgut et al. (2018) on the effect of flexibility deficits on scapular asymmetry in individuals with and without shoulder pain showed that a lack of flexibility in the pectoralis minor and posterior capsule had a significantly positive relationship with the angle of symmetry at rest, separately for both groups with and without shoulder asymmetry. However, there was no significant relationship between a lack of flexibility and asymmetry during arm elevation and lowering for both the symptomatic and asymptomatic groups (2).

In contrast, Hadzic et al. (2014) reported that among elite male volleyball players, the ratio of external to internal shoulder rotation strength was generally lower, regardless of playing position, skill level, or history of shoulder injury. In female players, however, this lower ratio was observed only in those with higher skill levels (3). Additionally, Daneshjoo et al. (2019) reported that volleyball players with shoulder asymmetry

exhibited greater muscle strength, while their shoulder rotation range of motion was limited. In this asymmetrical shoulder group, significant differences were observed between the dominant and non-dominant sides in both shoulder strength and range of motion, whereas players with symmetrical shoulders showed no such differences (24). Which was inconsistent with the results of this study. It is important to note that this study focused on shoulder asymmetry and did not specifically assess scapular asymmetry. Wang et al. (2001) examined mobility impairments, muscle imbalances, muscle weakness, scapular asymmetry, and shoulder injuries in elite volleyball players. Their findings indicated that the dominant arm exhibited a significantly lower active range of internal shoulder rotation and reduced external rotator strength, while internal rotators were significantly stronger. Furthermore, a correlation was observed between shoulder muscle imbalances, postural balance, and rotator strength in the dominant arm. The study suggested that imbalances in rotator cuff muscle strength may contribute significantly to shoulder injuries among high-level volleyball athletes (25). The differences between research results may be due to the type of sport, assessment of shoulders vs. scapulae, training histories, and the way the variables of interest were assessed.

Based on the findings and examination of the studies, it appears that performing movements through full and specific ranges of motion in CrossFit training can help prevent compensatory movements, muscle imbalances, and inadequate movement execution (26) and can potentially minimize negative effects stemming from existing imbalances caused by scapular asymmetry, which are often considered frequent contributing factors and mechanisms of injury (26). On the other hand, studies suggest that performing strength training with a full range of motion as a technical element, but with moderate loads, can help prevent limitations in range of motion (5). CrossFit workouts involve using body weight and different loads, performing movements at full range and different joint angles, with activation of all muscle groups in various directions. Given this information, the variety of movements through full and varied ranges of motion likely prevents scapular asymmetry from affecting FMS scores and shoulder joint stability in the group with scapular asymmetry. Therefore, this sport may reduce the intensity of injury risk factors.

V. Conclusion

Overall, CrossFit workouts, given their diverse movements and the execution of full ranges of motion, may help preserve shoulder girdle stability and function despite the presence of abnormalities and scapular asymmetry. However, since CrossFit is a relatively new sport and there is limited research on FMS scores and shoulder girdle stability among CrossFit practitioners, further studies are necessary to obtain more accurate findings. Therefore, it is recommended that other researchers use more precise laboratory tools and tests, and more specific classifications of CrossFit exercises, to examine muscle function and their effect on the stability and function of the shoulder, scapula, and upper extremity of these athletes. In CrossFit training, there is a need for precise coordination in the execution of movements and simultaneous use of upper extremity joints. This coordination strengthens weakened muscles or creates adaptations to muscular weaknesses. Regarding the results and analyses on the disruption of balance and coordination of the muscles around the scapula and shoulder girdle when scapular asymmetry is present, it appears that this type of training can help to compensate for and correct defects caused by scapular asymmetry.

It is essential to note that this does not disregard the need to correct existing misalignments but suggests that this type of activity can reduce limitations and movement problems. Although this sport may not directly correct scapular asymmetry or postural abnormalities, it is likely to have an impact on improving the quality of movement and performance. This difference is important to note, as previous studies involved non-athlete participants, whereas this study revealed some variations in athletes. Furthermore, it has not been addressed whether those who begin this sport develop scapular asymmetry, or whether they had this problem before training and that CrossFit training had no role in its development. It is recommended that future research further investigate these aspects.

References

- [1]. Cejudo A. Predicting The Clean Movement Technique In Crossfit® Athletes Using An Optimal Upper-Limb Range Of Motion: A Prospective Cohort Study. *International Journal Of Environmental Research And Public Health*. 2022;19(19):12985.
- [2]. Morton SK, Whitehead JR, Brinkert RH, Caine DJ. Resistance Training Vs. Static Stretching: Effects On Flexibility And Strength. *The Journal Of Strength & Conditioning Research*. 2011;25(12):3391-8.
- [3]. Moscatelli F, Messina G, Polito R, Porro C, Monda V, Monda M, Et Al. Aerobic And Anaerobic Effect Of Crossfit Training: A Narrative Review. *Sport Mont*. 2023;21(1):123-8.
- [4]. Page P, Frank CC, Lardner R. Assessment And Treatment Of Muscle Imbalance. (No Title). 2010.
- [5]. Salamh PA, Hannek WJ, Boles T, Holmes D, Mcmillan A, Wagner A, Kolber MJ. Is It Time To Normalize Scapular Dyskinesia? The Incidence Of Scapular Dyskinesia In Those With And Without Symptoms: A Systematic Review Of The Literature. *International Journal Of Sports Physical Therapy*. 2023;18(3):558.
- [6]. Suchomel TJ, Comfort P, Stone MH. Weightlifting Pulling Derivatives: Rationale For Implementation And Application. *Sports Medicine*. 2015;45:823-39.

- [7]. Akinoğlu B, Kabak B, Balci A, Kocahan T, Hasanoglu A. A Comparative Study Of Shoulder Muscle Strength, Sense Of Proprioception And Internal/External Rotation Flexibility Between Adolescent Athletes With And Without Scapular Asymmetry. *Advances In Rehabilitation*. 2020;34(3):1-7.
- [8]. Taspinar F, Aksoy CC, Taspinar B, Cimbiz A. Comparison Of Patients With Different Pathologies In Terms Of Shoulder Protraction And Scapular Asymmetry. *Journal Of Physical Therapy Science*. 2013;25(8):1033-8.
- [9]. Turgut E, Baltaci G. Effect Of Flexibility Deficit On Scapular Asymmetry In Individuals With And Without Shoulder Pain. *Brazilian Journal Of Physical Therapy*. 2018;22(5):370-5.
- [10]. Ueda A, Matsumura A, Shinkuma T, Oki T, Nakamura Y. Shoulder Kinetic During Pitching In Baseball Players With Scapular Dyskinesia. *Journal Of Bodywork And Movement Therapies*. 2024;37:57-62.
- [11]. Wang H, Cochrane T. Mobility Impairment, Muscle Imbalance, Muscle Weakness, Scapular Asymmetry And Shoulder Injury In Elite Volleyball Athletes. *Journal Of Sports Medicine And Physical Fitness*. 2001;41(3):403-10.
- [12]. Alizadeh M, Daneshmandi H, Shademan B, Ahmadizad S. The Effects Of Exercise Training On Scapula Position Of Muscle Activity Measured By EMG. *World J Sport Sci*. 2009;2:48-52.
- [13]. Escamilla RF, Yamashiro K, Paulos L, Andrews JR. Shoulder Muscle Activity And Function In Common Shoulder Rehabilitation Exercises. *Sports Medicine*. 2009;39:663-85.
- [14]. Hadzic V, Sattler T, Veselko M, Markovic G, Dervisevic E. Strength Asymmetry Of The Shoulders In Elite Volleyball Players. *Journal Of Athletic Training*. 2014;49(3):338-44.
- [15]. Jeong JH, Kim YK. Association Of Scapular Dyskinesia With Neck And Shoulder Function And Training Period In Brazilian Ju-Jitsu Athletes. *Medicina*. 2023;59(8):1481.
- [16]. Kibler WB, Sciascia A. Current Concepts: Scapular Dyskinesia. *British Journal Of Sports Medicine*. 2010;44(5):300-5.
- [17]. Kuniki M, Iwamoto Y, Konishi R, Kuwahara D, Yamagiwa D, Kito N. Neural Drive And Motor Unit Characteristics Of The Serratus Anterior In Individuals With Scapular Dyskinesia. *Journal Of Musculoskeletal & Neuronal Interactions*. 2024;24(2):148.
- [18]. Manaye S, Cheran K, Murthy C, Bornemann EA, Kamma HK, Alabbas M, Et Al. The Role Of High-Intensity And High-Impact Exercises In Improving Bone Health In Postmenopausal Women: A Systematic Review. *Cureus*. 2023;15(2).
- [19]. Mehrab M, Wagner RK, Vuurberg G, Gouttebarger V, De Vos R-J, Mathijssen NMC. Risk Factors For Musculoskeletal Injury In Crossfit: A Systematic Review. *International Journal Of Sports Medicine*. 2023;44(04):247-57.
- [20]. Burn MB, McCulloch PC, Lintner DM, Liberman SR, Harris JD. Prevalence Of Scapular Dyskinesia In Overhead And Nonoverhead Athletes: A Systematic Review. *Orthopaedic Journal Of Sports Medicine*. 2016;4(2):2325967115627608.
- [21]. Comfort P, Williams R, Suchomel TJ, Lake JP. A Comparison Of Catch Phase Force-Time Characteristics During Clean Derivatives From The Knee. *The Journal Of Strength & Conditioning Research*. 2017;31(7):1911-8.
- [22]. Caine DJ, Nassar L. Gymnastics Injuries. *Med Sport Sci*. 2005;48:18-58.
- [23]. Meier N, Schlie J, Schmidt A. Crossfit®: 'Unknowable' or Predictable?—A Systematic Review On Predictors Of Crossfit® Performance. *Sports*. 2023;11(6):112.
- [24]. Arghadeh R, Alizadeh MH, Minoonejad H, Sheikhhoseini R, Asgari M, Jaitner T. Electromyography Of Scapular Stabilizers In People Without Scapular Dyskinesia During Push-Ups: A Systematic Review And Meta-Analysis. *Frontiers In Physiology*. 2023;14:1296279.
- [25]. Cools AM, Struyf F, De Mey K, Maenhout A, Castelein B, Cagnie B. Rehabilitation Of Scapular Dyskinesia: From The Office Worker To The Elite Overhead Athlete. *British Journal Of Sports Medicine*. 2014;48(8):692-7.
- [26]. Claudino JG, Gabbett TJ, Bourgeois F, Souza Hds, Miranda RC, Mezêncio B, Et Al. Crossfit Overview: Systematic Review And Meta-Analysis. *Sports Medicine-Open*. 2018;4:1-14.