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ARE SHOULDER MOBILITY TEST SCORES RELATED TO THROWING PERFORMANCE OR ARE THEY AN INJURY SIGNAL?

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ABSTRACT

Throws branch is a sport that has the risk of injury due to the movement patterns consisting of excessive repetitions and the need for explosive power production. For this reason, it is important for the athlete's sports career to be able to determine the injury risks beforehand and to take protective measures. This study was aimed to evaluate the functional movement scores of young athletes competing in throwing branches.

A total of 11 athletes (7 male and 4 female, aged 14-19), who participated in regional and national competitions and continued training regularly, were participated in the study. After analyzing the physical and anthropometric characteristics of the participants (height, body weight, body mass index and body composition parameters) Functional Movement Screen (FMS™) test measurements were applied.

Trunk stability push-up test had the lowest average score of 2.18 in the test. In male participants, hurdle step, in-line lunge, trunk stability push up shoulder mobility test results demonstrated that was asymmetry. Active straight leg raise and shoulder mobility test results in asymmetry results in female participants are remarkable. The functional movement screening test total score average was found to be 17 for both genders. Also non-significant correlations between shoulder mobility and overhead medicine ball throwing tests.

The results showed that shoulder mobility test scores cannot be used to predict throwing performance in young track and field thrower athletes. There is a need for studies with large participant groups evaluating both genders in sports that use repetitive movement patterns in future research.

Keywords: Shoulder mobility, injury risk, prevention, adolescent athletes, throwers

INTRODUCTION

Throwers branch includes a training structure that requires high power output and causes excessive repetition of similar movement patterns in the same joint and muscle structures. According to the data of the IAAF, throwing has the 3rd highest injury rate among track and field branches (Alonso et al., 2012). Especially in the structure where many joint and muscle groups such as the shoulder complex work in harmony, excessive repetitions at similar angles can cause some deterioration in the structure of the shoulder (Mohammed A. Miniato & Prashanth Anand, n.d.; Paine & Voight, 1993). Training models that do not include structured systematic strength training and corrective exercise strategies to protect and improve shoulder health may cause higher injury risks and injuries (Lauersen et al., 2018; Zarei et al., 2021). In the literature, the physical distribution of injuries in athletes is 51.1% upper extremity, 25.9% lower extremity, 12.6% head/neck/spine, 10.4% core and 1% scalp injuries (Lee et al., 2018)

Injuries that may occur in developmental athletes may cause the athlete's inability to benefit from the limited training windows, withdrawal from sports, psychological problems and rapid physical profile deterioration (fat tissue increase, muscle loss). Especially repetitive injuries such as the shoulder can cause the athlete to quit the sport.

Throws are part of the sport of athletics, which is based on high power output in a short time, aiming to drop the material as far as possible. It includes a total of 4 different branches including shot put, hammer, discus and javelin(Nuanes, 2015). In order to have a good throwing performance,

biomechanically high quality of movement (Badura, 2010), the anthropometric character of the athlete (Katie R. Hirsch, Abbie E. Smith-Ryan, Eric T. Trexler, 2016), muscle content, size and functionality (Terzis et al., 2007), neuronal quality (Thomas A. Kyriazis, Gerasimos Terzis, Konstantinos Boudolos, 2009) and the potential for firing and recruitment of motor units (Bazyler et al., 2017). On the other hand, the risk of injury is very high due to the sudden production of power output. The absence of any stable phase in the transition from the eccentric phase to the concentric phase, especially in the throwing movement performed at the shoulder joint, is among the main reasons for this risk. The practice of repeated incorrect movement forms in training and competitions is one of the most important reasons for the risk of serious and long-term injury. Due to the nature of the branch, the technique and the fatigue caused by excessive repetitions during the throwing make the risk of injury clear (Nuanes, 2015). Although meniscal injuries due to rotation in the shot put and discus throw are common, finger lesions can be seen in the discus thrower due to the material coming out of the finger last. In hammer throwing, skin injuries may occur due to friction of the palm and fingers under the handle with the speed of the hammer (Li, 2021). In javelin throwers, removing the material from the shoulder with maximum force, as the elbow joint is at its most tense point, can cause serious elbow-shoulder problems (Nuanes, 2015).

The functional movement scores screening test (FMS™) is a test battery with high validity and reliability used in the preliminary detection of functional capacity by screening 7 different movement patterns (Domaradzki & Koźlenia, 2020). There are studies in the literature to determine the risk of injury, especially in athletes. Looking at the recent literature, Valdez J. Crouse reported in his study that the FMS™ battery is highly correlated with basic motoric features such as flexibility and coordination (Crouse, 2014). In another study, Mokha et al. Evaluated the effects of a 12-week corrective exercise program adapted to the training program in their research with cross country runners. At the end of the study, it was concluded that the FMS™ scores increased, and accordingly, the peak angle values were reached in the pelvis, hip and ankle movements, and the mobility of the knee joint increased(Monique Mokha, Yelizaveta Buluchevskaya, 2020). Giovanna Nuanes evaluated shoulder mobility in the values she received before and after the shoulder exercise program, she designed in her study with overhead-throwing athletes. As a result of the study, a significant increase in shoulder mobility was detected (Nuanes, 2015). Recently, Jie Li has evaluated the performance of the young Hammer Throw Athletes with the visual analysis method in his work. As a result of the study, he reported that the trio of functional movement, height and body weight in the hammer throw was correlated blindly. In addition, he suggested that coaches constantly evaluate these three parameters in their athletes and include them in the performance output. (Li, 2021).

The main hypothesis of the study is to evaluate the relationship between physical performance outputs and test results from a regional and cumulative perspective through the FMS™ test battery in young thrower athletes. Another hypothesis is to evaluate the injury risk levels in young thrower athletes.

DATA COLLECTION

The research group consists of athletes who live in Izmir and regularly train and take part in regional and national championships for at least 2 years. A total of 11 athletes (7 male and 4 female) in the 14-19 age range were included in the study. Inclusion criteria for this study were defined as not suffering from an injury in the past 30 days that precludes full participation in pre-season training and/or conditioning programs. Athletes who could not meet this criterion were not included in the study. Athletes under the age of 18 participated in the measurements voluntarily by their families, and athletes over the age of 18 signed the participation form by themselves. The study was approved by the Ethics Committee of Dokuz Eylul University (Approval Number 4581-GOA).

Subjects were tested within two weeks of the beginning of their training seasons. Athletes performed the FMS™ test with anthropometric measurements. Anthropometric and all physical measurements of the athletes were made between 9.00-11.00 in the morning. One hour before the measurement time, the participants were asked to stop consuming food and drink completely. The height of the athletes, without shoes, in shorts and T-shirts, was automatically measured on the stadiometer by determining the peak while their back was turned. Body composition analysis was measured with Biospace In body 720. Men measured with shorts, women with short tights and bustiers.

Functional Movement Screen Test Battery (FMS™) : FMS™ test is a screening test protocol used to determine joint stabilization, mobilization, joint range of motion, and symmetrical and asymmetrical conditions in the body using 7 different motion forms (Monique Mokha, Yelizaveta Buluchevskaya, 2020). The assessment of the current functional state of the locomotor movement system while performing the protocol. The 7 subtests in this protocol are (1) Deep Squat, (2) Hurdle Step, (3) In-Line Lunge, (4) Active Straight Leg Lift Raise, (5) Trunk Stability Push-Up, (6) Rotary Stability. and (7) Shoulder Mobility (Domaradzki & Koźlenia, 2020).

The FMS™ test protocol includes an application process, taking into account the basal state of their bodies, without applying any warm-up protocol to the participants. Before the test, the movements to be performed in the protocol are explained and introduced one by one, verbally and visually. All movements are performed in the order specified by each participant. For evaluation, each movement is asked to be repeated three times and the evaluation is made over the repetitions. In bidirectional movements, each leg and shoulder are evaluated three times in separate directions, right and left.

Evaluation of FMS™ Test Battery

In the evaluation of the movement forms, the participants are asked to repeat a movement form 3 times. During these repetitions, the evaluation is carried out with a 0-3 scoring method over the correct technique and movement from (Monique Mokha, Yelizaveta Buluchevskaya, 2020). The score evaluation is given in Table 1 below.

The total result obtained because of performing the movement forms is 21 points and this score constitutes the FMS™ overall result. The FMS™ overall score includes the highest grade for each test. Low grades are taken into account in bilateral tasks. In movements with pain, only positive results are taken into account, and 0 points are given for negative or incomplete movement forms (Domaradzki & Koźlenia, 2020).

Participants whose FMS™ overall result was between 15 and 21 were evaluated as individuals with joint range of motion stabilization and mobilization and joint range of motion at moderate or higher levels, and whose asymmetry and symmetry were not seen at a high rate. In the participants whose FMS™ general result is below 14 out of 21, the presence of asymmetries, joint motion stabilization and mobilization and joint range of motion are at a low level. In the participants with a score of less than 14, an assessment of the risk of injury was made and joint movement failures were evaluated as likely to occur (Mokha et al., 2020).

Table 1: Functional Movement Screening Test Scoring Table

Score	**Description**
0 Point	Performing the movement in the wrong form or reporting the occurrence of pain by the participants
1 Point	Co-occurrence of problems such as technical limitations and asymmetry during the movement
2 Point	Tolerable minor limitations and asymmetrical situations while performing the movement
3 Point	Performing the movement with the correct form

Statistical Analysis

Statistical analyzes were performed using the IBM SPSS (Statistical Package for the Social Sciences) 23 package program. Shapiro–Wilk test was applied to determine the normality and distribution of the data. The student's t-test was used to compare the participants' data and determine the differences between the right and left regions. The Pearson Correlation test was applied to evaluate the correlations of the measurements in shoulder mobility and overhead medicine ball throwing scores.

FINDINGS

Demographic information and physical measurement values of the athletes participating in the research are given in Table 2.

Table 2: Demographic and physical measurement values of the throwers

Parameters	Women n=4 Mean. ± Ss	Men n=7 Mean. ± Ss	All Athletes n=11 Mean. ± Ss
Age (year)	18 ± 0.81	16 ± 1.63	16.7 ± 1.67
Training Age (year)	5,5 ± 1,91	3 ± 1,52	3,90 ± 2,02
Height(cm)	174,75 ± 6.05	183 ± 3.81	1.80 ± 6.49
Weight(kg)	77.42 ± 10.33	84.2 ±10.73	81.73 ± 10.62
Body Mass İndex (kg/m^2)	25.62 ± 5.33	25.17 ± 3.24	25.33 ± 3.86
Body Fat Percentage (%)	25.97 ± 12.07	16.37 ± 5.65	19.86 ± 9.29

The mean age of the athletes included in the study was 18 ± 0.81 for women, 16 ± 1.63 for men, 5.5 ± 1.91 for women, 3 ± 1.52 for men, 5.5 ± 1.91 for women, and 3 ± 1 for men. .52, mean body weight was 174.75 ± 6.05 in women, 84.2 ±10.73 in men, mean body mass index was 25.62 ± 5.33 in women, 25.17 ± 3.24 in men, mean body fat percentage was 25.97 ± 12.07 in women and 16.37 ± 5.65 in men.

The average values of the functional movement screening test of the athletes participating in the research are given in Table 3.

Table 3: Functional Movement Screening Test (FMS™) Scores of the Throwers

FMS™ Score		**Women** n=4 Mean. ± Ss	**Men** n=7 Mean. ± Ss	**All Athletes** n=11 Mean. ± Ss
Deep Squat Score		2.75 ± 0.5	2.28 ± 0.75	2.45 ± 0.68
Hurdle Step Score	Right	2.25 ± 0.5	2.71 ± 0.48	2.54 ± 0.52
	Left	2.25 ± 0.5	2.14 ± 0.37	2.18 ± 0.40
	Mean	2.25 ± 0.5	2.42 ± 0.34	2.36 ± 0.39
In-Line Lunge Score	Right	3 ± 0	3 ± 0	3 ± 0
	Left	3 ± 0	2.85 ± 0.37	2.90 ± 0.30
	Mean	3 ± 0	2.92 ± 0.18	2.95 ± 0.15
Active Straight Leg Raise Score	Right	2.75 ± 0.5	2.57 ± 0.53	2.63 ± 0.5
	Left	3 ± 0	2.71 ± 0.48	2.81 ± 0.40
	Mean	2.87 ± 0.25	2.64 ± 0.37	2.72 ± 0.34
Trunk Stability Push Up Score		1.75 ± 1.5	2.42 ± 0.78	2.18 ± 1.07
Rotary Stability Score		2.50 ± 0.57	2 ± 0	2.18 ± 0.40
Shoulder Mobility Score	Right	2.50 ± 1	2.14 ± 0.89	2.27 ± 0.90
	Left	3 ± 0	2.71 ± 0.75	2.81 ± 0.60
	Mean	2.75 ± 0.5	2.42 ± 0.73	2.54 ± 0.65
Total Score		17.87 ± 1.65	17.14 ± 1.31	17.40 ± 1.41

The average scores of the Functional Movement Screening Test of throwing athletes participating in the research are given in Table 3. The in-line lunge in which the athletes had the highest score in the test was 2.95 ± 0.15 points and active straight leg raise was 2.72 ± 0.34 points. The movements with the lowest score for the athletes were the trunk stability push-ups with 2.18 ± 1.07 points and the rotary stability with 2.18 ± 0.40 points. The total score of the athletes was obtained as 17.40 ± 1.41 points.

There is a numerical difference in the right region in the scores of hurdle step, in-line lunge, active straight leg raise and trunk stability push up in male participants. In addition, there is a numerical increase in shoulder mobility movement in the left region. In female participants, there is a numerical difference in the right region in the scores of hurdle step, in-line lunge, trunk stability push up. In addition, a numerical increase is observed in the left region in shoulder mobility and active straight leg raise.

Table 4: Correlation between FMS™ Shoulder Mobility Score and Overhead Medicine Throwing Test Scores

FMS™ Score		**OSMBC**	**ODMBC**	**OSSMBC**	**OSDMBC**
Shoulder Mobility Test Scores	Left	0.771	0.773	0.836	0.576
	Right	0.679	0.885	0.777	0.816
	Mean	0.672	0.954	0.920	0.924

OSMBC; overhead static medicine ball score, ODMBC; overhead dynamic medicine ball score, OSSMBC; overhead standing static medicine ball score OSDMBC; overhead standing dynamic medicine ball score. Correlation is significant at the 0.01 level (2-tailed).

Correlational data results showed non-significant correlations between Shoulder Mobility and Overhead Medicine Ball Throwing tests.

DISCUSSION

It was aimed this study evaluate the relationship between some physical performance outputs and test results from a regional and cumulative perspective through the FMS™ test battery in young track and field thrower athletes. The main finding showed no correlations between throwing and shoulder mobility test results.

The FMS™ battery has an important place in training planning for many sports branches, as it is a test battery that provides information about the risk of injury and range of motion (Chorba et al., 2010) FMS™ is a measurement battery that is used in all populations to determine joint stabilization, mobilization, joint range of motion, and symmetrical and asymmetrical conditions, as well as to predict injuries that may occur due to repetitive movements in athletes in developmental age and to take precautions. Specifically, in this study, it was shown that the shoulder mobility test, which is a part of the FMS™ test battery, was not associated with throwing performance when evaluated alone.

When the average BMI values and body fat percentages of the participant group were examined, it was observed that they were at a level that could pose a risk of being overweight after the developmental period. O'Brien. et al. systematically reviewed and analyzed functional movement competencies in children and adolescents. The study evaluated the results of other literature studies that evaluated using FMS™ using Preferred Reporting Items for Systematic Reviews and Meta-Analysis. As a result of this evaluation, the initial norm value was tried to be established by evaluating gender, education level (children and adolescents at primary and secondary school level) and body mass index (BMI). As a result of the study, possible gender, and age-related differences in FMS™ scores emerged. In addition, a negative relationship was noted between BMI and functional mobility (O'Brien et al., 2022). Similarly, Jie Li observed that functional movement and BMI parameters were related in young athletes in the hammer throw branch in his study. He reported that coaches should regularly apply the FMS™ test to developmental athletes and focus on performance improvement by constantly evaluating these three parameters (Li, 2021). Our findings once again reveal the necessity of following anthropometric data in terms of healthy growth and functional movement.

The results of the FMS™ test were evaluated, and the gender difference was emphasized in the literature studies. Anthropometric differences depending on gender in male and female athletes also affect the results of this battery. Domaradzki et al. aimed to determine the reliability of the FMS™ test battery and the gender differentiation in the values of the subtests in this battery and the difference between the genders of the injury risk values with the FMS™ test applied to this population by including 89 physically active individuals (42 men, 47 women) who did not do high-performance sports with a mean age of 20.5 years. As a result of the study, the FMS™ test showed a perfect match between the two genders. Some differences were found in the quality of movement patterns between men and women, especially in lower extremity tests. These differences showed that the injury risk scores differed between the gender, but this value was 14 points for men and 17 points for women (Domaradzki & Koźlenia, 2020). The findings obtained in this study are similar to our study, and the numerical difference between the gender was also revealed. However, in our study, injury risk values were close in both genders and differed from the current study (men = 17.14 ± 1.31, women = 17.87 ± 1.65). The FMS™ tests are applied in physically active groups, many literature studies apply the test battery to athletes. Valdez J. Cruise started with the hypothesis in his study that the FMS™ battery is highly correlated with basic motoric properties such as flexibility and coordination. In this study, 99 participants actively competing in a professional football team were included and an FMS™ battery was applied to all participants before and during the season. In the findings, no relationship was found between the FMS™ score and the risk of injury, but the findings were related to anthropometric measurements in terms of predicting athletic performance. In particular, he reported that FMS™ score and body fat percentage were associated with predictors of strength, speed/agility, and strength athletic performance. (Crouse, 2014). In another study evaluating athletic performance, Mokha et al. In their study with nine healthy, university male (n=2) and female (n=7) cross country runners, observed the effects of a 12-week corrective exercise program integrated into the current training program of the athletes on athletic performance. At the end of the study, all participants improved and increased their FMS™ total scores and it was concluded that the joint range of motion of the pelvis, hip and ankle increased. (Monique Mokha, Yelizaveta Buluchevskaya, 2020).

Recent studies in the literature; in a study of thrower athletes, Nuanes G. evaluated the FMS™ of twenty National Collegiate Athletic Association (NCAA) softball players. In the study, the 6-week effects of a program called Throw 10, designed to help athletes who throw overheads strengthen and support the mechanics of the shoulder complex muscles, were evaluated. As a result, no significant overall difference was observed between the pre and post-test measurements. However, shoulder mobility was significantly increased (pre=1.95±0.759, post= 2.30±0.801) (Nuanes, 2015). Another study observing competitive throwers, Kim. et al. the effect of 8-week specific training performed in javelin throwers on rotator cuff muscle strength and throwing technique was observed. To evaluate the effects of the training, pre and post FMS™ measurements were made on the experimental group. When the study results were evaluated, statistically significant increases were observed in FMS™ score and external-internal rotator muscle strength after training (Kim et al., 2014). Gustafson et al. in their study applied FMS™ to twenty-one female (20.0_± 1.4 age) throwing athletes before and after the season. Considering the results of the study, there was no difference between pre-and post-season scores (pre=14.8 ± 2.5, post= 15.6 ± 2.2,). Deep Squat and Right Shoulder Mobility improved, while Left Hurdle Step average scores are decreased (Gustafson, 2019). This result is similar to the difference between right and left scores in study findings. Also, these findings show that asymmetry problems tend to increase due to repetitive movements. When planning corrective and strength exercises, the need for different exercise interventions locally in the dominant regions should be taken into account.

CONCLUSION

Study results showed that shoulder mobility test scores cannot be used to predict throwing performance in young track and field thrower athletes. In addition, it was thought that the FMS™ test is valuable in predicting the risk of injury, and continuous testing of the movement form of the FMS™ in relation to the relevant joint in branches that perform repetitive movements is an effective method of preventing injuries. There is a need for studies with large participant groups evaluating both genders in sports that use repetitive movement patterns in future research.

LIMITATIONS

The low number of participants of both genders and test-re test experimental approach are limitations of this study.

PRACTICAL APPLICATIONS

Regular testing and follow-up of the effects of the applied training modules on functional movement mechanics are important for reducing the risk of injury and improving the quality of movement. There is a need for corrective and strength exercises for injury prevention, especially in young track and field thrower athletes.

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