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ORIGINAL RESEARCH PAPER

FUNCTIONAL MOVEMENT SCREEN (FMS^{TM}) AND BALANCE IN BODYBUILDERS DURING THE DEFINITION PERIOD

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Abstract

The functional movement and balance performances of bodybuilders and the relationship between them arouse curiosity in the definition period where intense restrictions are experienced. The aims of this study were to (a) determine functional movement screening (FMS^{TM}) and balance performance in bodybuilders during the definition period and (b) examine the relationship between these tests. Twelve adult male bodybuilders voluntarily participated in the study. Participants performed flamingo balance test for static balance, upper & lower quarter Y-balance test (YBT-LQ & YBT-UQ) for dynamic balance, and FMS ^{TM} tests (deep squat, hurdle step, in-line lunge, shoulder mobility, active straight leg raise, trunk stability push-up, and rotary stability) for functional movement screening. There was a significant negative correlation between dominant leg static balance and rotary stability (r=-.832, p=.040) and a significant positive relationship between dynamic balance and rotary stability in dominant and non-dominant leg (dominant leg: r=.589, p=.044, non-dominant leg: r=.775, p=003). There was no significant relationship between YBT-UQ composite scores and FMS^{TM} composite scores on both sides in bodybuilders during the definition period. As a result, the FMS ^{TM} score is quite low in bodybuilders during the definition period, and the increase in static and lower extremity dynamic balance performance may increase the rotary stability score. Bodybuilders are recommended to practice lower extremity static and dynamic balance exercises in addition to training during the definition period.

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Key words: *Bodybuilding, functional movement screen, balance.*

Introduction

Bodybuilding is one of the most fundamental exercise methods to increase coordination, balance and muscle strength (Steele et al., 2019). The use of multi-joint exercises such as bodybuilding has been reported to improve coordination, balance and proprioception (Vaughn & Micheli, 2008). In bodybuilding where additional equipment is used, there is a risk of injury during movements such as squats, weightlifting and pulls and similar movements (Matuliunas, 2020). It is very important to determine the strengths and weaknesses of the athletes, since they are exposed to more biomechanical loads than they can tolerate, which also brings the risk of injury (Arghadeh et al., 2018). It has been reported that as the frequency of weekly training decreases in bodybuilding and fitness sports, there is an increase in the elbow, wrist, forearm, and foot-ankle injuries (Çetinkaya et al., 2017).

Some tests that can predict injury, such as balance and FMS^{TM}, are functional screening tools used by coaches and clinicians to determine physical dysfunctions or functional asymmetries. The YBT-LQ test, one of the dynamic balance tests, is used to measure trunk and lower extremity function (Cengizel & Cengizel, 2019; Myungsun Lee & Han, 2016).

In the literature, there is no consensus in studies conducted with FMS^{TM} and balance. In a study, it was determined that dynamic balance can be predicted with FMS^{TM} test scores. The scores of 2 on the deep squat and 3 on the trunk stability push-up movements predicted a greater composite reach. In addition rotary stability score of 3 predicted better overall stability indices. In addition, having a higher FMS^{TM} score (score higher than 14) exhibits higher composite reach (Scudamore et al., 2019). Conversely, another study shows that injury history negatively affects FMS^{TM} performance and does not affect YBT performance (Chimera et al., 2015). It has also been reported that static balance measurements in stable and unstable conditions do not discriminate groups of young adults assessed by the FMS^{TM} (Trindade et al., 2017). Perry (2015) did not find a significant relationship between FMS^{TM} and balance in hockey players ($r=0.14$, $p=0.67$). While it was found that the FMS^{TM} composite score did not change in acute responses after exercise and was not associated with static balance, a significant relationship was determined between exercise-related changes during static balance and hurdle step, in-line lunge and active straight leg raise (ASLR) (Clifton et al., 2013).

While preparing athletes for competitions in bodybuilding involves long training periods, this preparation process consists of two phases: (a) bulking (b) cutting.(Steele et al., 2019) The bulking phase is characterized

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by the aim of maximizing muscle growth, often using a rigid meal plan, and maintaining the anabolic process and lasts for months (Lambert et al., 2004). The cutting phase is characterized by fat loss, muscle mass preservation and calorie reduction and contains 8 – 16 weeks before competitions (Hackett et al., 2013; Lambert et al., 2004). Muscle definition is achieved through reduction of muscle glycogen sources and dehydration of the muscles (restriction of water and sodium intake, often the use of diuretics the day before the competition) in the last week before the competition (Steele et al., 2019; Steen, 1991). The functional movement and balance performances of bodybuilders and the relationship between them arouse curiosity in this definition period where intense restrictions are experienced. In the literature, some studies using these tests that can predict the risk of injury have been found (Altundağ et al., 2021; Atalay & Atalay, 2021; Daneshjoo et al., 2020; Zarei et al., 2022). There are also studies examining the relationship between FMS ™ and balance in different sports disciplines (Arazzadeh & Norastch, 2018; Harshbarger et al., 2018; Kramer et al., 2019; Lisman et al., 2018; Pourheydari et al., 2018). However, research on FMS™ and balance performance in bodybuilders is very limited (Matuliunas, 2020; Tafuri et al., 2016). To the best of author's knowledge, there is no study investigating the FMS™ and balance performance of bodybuilders during the definition period. Therefore, the aims of this study were to (a) FMS™ and balance performance in bodybuilders during the definition period and (b) to examine the relationship between these tests.

Materials and Methods

Participants. The current study is is a cross-sectional and correlational study conducted with field performance and screening tests. Twelve healthy adult male bodybuilders voluntarily participated in the study. Ten of the participants compete in athletic physics and two in bodybuilding disciplines. Athletes were informed about the study protocol before the measurements and informed consent were obtained. All athletes participated in the measurements while they were in the definition period. Inclusion criteria were (a) being an adult male bodybuilder (b) training for a minimum of 4 hours per week (c) having a definition period (d) having participated in bodybuilding competitions at least once (e) being actively preparing for competitions. Exclusion criteria were (a) having any musculoskeletal injury or operation in the last six months (b) experiencing a bulking phase (c) not participating in one of the test protocols or leaving voluntarily. Before the measurement, the dominant legs of the athletes were questioned. The leg that was thrown forward first in the forward falling motion while in the anatomical stance was accepted as the dominant leg. The dominant leg of the three participants was the left and all

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the remaining athletes were the right. The research was carried out according to Helsinki Declaration and was approved by the University Ethics Committee (Research code: 2022-077).

Study design. Measurements were taken in a single day before the competition. Flamingo balance test for static balance, YBT-LQ & YBT-UQ test for dynamic balance, FMS^{TM} test for functional movement were applied in the measurements, respectively. Balance measurements were performed on the dominant and then non-dominant sides of the athletes.

Static balance. Flamingo balance test was used to measure static balance. Familiarization was applied to the athletes for 10 seconds before the test. In this test, the athlete stood in balance with one foot on a metal balance beam (50cm long, 4cm high and 3cm wide) and bent the other foot back at the knee, pulled it toward his hip, and held it with the hand on the same side. In this position, the athlete tried to stay in balance while maintaining his body integrity. As soon as the position was achieved, the time was started with the stopwatch. It was asked to maintain this balanced state for one minute. When the balance is disturbed (if he releases his foot while holding it with his hand, falls off the balance board, touches the ground with any part of his body, etc.), the timer is stopped. When the athlete got on the balance beam and regained his balance, the time was restarted from where he left off. The number of falls of the athlete during one minute was recorded as the static balance score. After the test was applied to both sides, it was repeated two more times and the average of three trials was recorded.

Lower Quarter Y-Balance Test (YBT-LQ)

Lower quarter Y-Balance test (YBT; Move2Perform, Evansville, IN) was applied to measure lower extremity dynamic balance according to criteria described by Plisky et al. (2009) In this test, the athletes were asked to lie on the Y-shaped strip on the floor (angle of 135 degrees between the anterior and posterior directions and 90 degrees between the posterior directions) while balancing with one foot, while reaching out in the directions (anterior, posteromedial, posterolateral) determined with the other foot. Maximum reach percentage calculated by dividing reach distances by leg length. The composite score was calculated by dividing the sum of the three directions by three times the leg length. Dominant-to-non-dominant side reach distance difference were calculated in cm (reach distance difference = [maximum dominant reach distance – maximum non-dominant reach difference]) (Lisman et al., 2018). Dynamic balance was applied 3 times in each direction. Scores were recorded separately for the dominant and non-dominant leg. Internal reliability of this test was reported as excellent (ICC=0.88–0.99, $p \leq 0.01$) (Feizolahi & Azarbayjani, 2014).

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Upper Quarter Y-Balance Test (YBT-UQ). Upper quarter Y-Balance test (YBT; Move2Perform, Evansville, IN) was applied to measure upper extremity dynamic balance. In this test, the athletes were asked to lie on the Y-shaped strip on the floor (angle of 135 degrees between the medial and lateral directions and 90 degrees between the lateral directions) while balancing with one hand, while reaching out in the directions (medial, superolateral, inferolateral) determined with the other hand. The Maximum reach percentage was calculated by dividing reach distances by arm length. The composite score was calculated by dividing the sum of the three directions by three times the arm length Dominant-to-non-dominant side reach distance difference were calculated in cm (reach distance difference = [maximum dominant reach distance – maximum non-dominant reach difference]) (Lisman et al., 2018). Dynamic balance was applied 3 times in each direction. Scores were recorded separately for the dominant and non-dominant leg. Internal consistency of this test was reported as excellent (ICC=0.80–0.99) (Gorman et al., 2012).

Functional movement screen. FMS^{TM} test consists of seven fundamental movements that include mobility and stability balance. These are deep squat, hurdle step, in-line lunge, shoulder mobility, ASLR, trunk stability push-up, rotary stability (Cook et al., 2014b, 2014a). Before the FMS^{TM} analysis, the athletes were asked not to start training and not to do any stretching exercises in order not to affect the analysis results due to the test procedure. Measurements were taken by an FMS^{TM} certified specialist. During the measurements, first unilateral tests (deep squat, trunk stability push-up) and then bilateral tests (hurdle step, in-line lunge, shoulder mobility, ASLR, trunk stability push-up, rotary stability) were applied. Right and left were scored separately in bilateral tests and the lowest point was recorded as a score. Each movement was scored range between 0 and 3 point. FMS^{TM} composite score was obtained by summing the scores from each test. The maximal composite score was 21 points (Gray Cook et al., 2006). Individuals with an FMS^{TM} composite score below 14 points were found to have a higher risk of injury than individuals with a higher than 14 points (Kiesel et al., 2007). Excellent reliability was reported for this test (ICC=0.89) (Onate et al., 2012). For each group's testing session, the same researcher evaluated the FMS^{TM} test for all participants.

Data analysis. Data analysis was performed using Sigma Plot 11.0 (Systat Software, Inc., San Jose, USA) software. The normality of the data distribution was determined by the Shapiro Wilk test. Descriptive statistics were presented as mean, standard deviation, minimum value, maximum value, and 95% confidence interval (CI). Paired t-test was applied to determine the difference between the participants' dominant and non-

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dominant side balance tests. The relationship between FMS ^{TM} with static and dynamic balance was determined by the Pearson correlation test. Correlation coefficients were interpreted as 0.0=little or no correlation, 0.2 to 0.4=fair correlation, 0.4 to 0.6=moderate correlation, 0.6 to 0.8=high correlation, and above 0.8=very high correlation. The significance level was accepted as 0.05.

Results

The mean age of the bodybuilder (n=12) participating in the study was 29.7±7.5 years, sports age 7.0±4.2 years, body height 174.9±4.8cm, body weight 80.0±11.5kg, body mass index 26.1±2.7kg.m^{-2} and weekly training time 5.3±1.0 hours (Table 1).

Table 1.

Characteristics of the bodybuilders

	Mean±SD	Max	Min	%95 CI
Age (years)	29.7 ± 7.5	46.0	23.0	25.5 – 33.9
Years of experience (years)	7.0 ± 4.2	15.0	1.0	4.6 – 9.4
Body height (cm)	174.9 ± 4.8	187.0	169.0	172.2 – 177.6
Body weight (kg)	80.0 ± 11.5	102.4	70.0	73.5 – 86.5
Body mass index (kg.m^{-2})	26.1 ± 2.7	32.3	23.4	24.6 – 27.6
Weekly training time (hours)	5.3 ± 1.0	7.0	4.0	4.7 – 5.9

SD: Standard deviation, Max: Maximum, Min: Minimum, CI: Confidence Interval.

Static and dynamic balance descriptive statistics of bodybuilders and comparison of dominant and non-dominant side in balance performance are presented in Table 2. The static balances of the participants were not significantly different between the dominant and non-dominant sides (p=.250, diff=-2.0). However, six of the participants could not perform the test because they could not even take the starting position required for static balance. ANT reach distance (cm, p=.025, diff=-2.5) and ANT maximum reach percentage (%, p=.012, diff=-2.9) in lower extremity dynamic balance were significantly different between dominant and non-dominant sides, while SL reach distance (cm, p=.020, diff=-4.8) and SL maximum reach percentage (%, p=.018, diff =-4.8) in upper extremity dynamic balance were significantly different between limbs.

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Table 2.

Comparison of dominant and non-dominant side balance performance of bodybuilders

	Dominant		**Non-dominant**			
	Mean ± SD	%95 CI	Mean ± SD	%95 CI	p	Diff
Static balance (no of falls,n=6)	12.2±2.5	10.2-14.2	10.2±3.7	7.2-13.2	.250	-2.0
Dynamic balance YBT-LQ						
ANT (cm)	82.2±8.8	77.8-87.8	84.7±7.3	80.6-88.8	.025	-2.5
PM (cm)	94.3±11.2	88.0-100.6	93.7±13.1	86.3-101.1	.729	.7
PL (cm)	85.8±11.4	79.4-92.3	86.8±16.9	77.2-96.4	.754	-1.0
Max % ANT	88.4±9.4	83.1-93.7	91.3±7.3	87.2-95.4	.012	-2.9
Max % PM	101.5±11.6	94.9-108.1	100.9±13.3	93.4-108.4	.724	.6
Max % PL	92.4±12.0	85.6-99.2	93.6±17.8	83.5-103.7	.766	-1.2
Composite score	94.1±9.5	88.8-99.5	95.3±11.8	88.6-102.0	.490	-1.2
YBT-UQ						
Medial (cm)	100.1±6.7	93.3-103.9	100.3±6.4	96.7-103.9	.911	-.2
IL (cm)	73.7±14.6	65.4-82.0	74.2±19.6	63.1-85.3	.863	-.5
SL (cm)	52.8±11.1	46.5-59.1	57.6±10.5	51.7-63.5	.020	-4.8
% Medial	100.4±9.0	95.3-105.5	100.7±9.8	5.2-16.2	.850	-.3
Max % IL	73.9±14.9	65.5-82.3	74.1±18.6	63.6-84.6	.937	-.2
Max % SL	53.0±11.9	46.3-59.7	57.8±10.8	51.7-63.9	.018	-4.8
Composite score	75.8±9.8	70.3-81.3	77.5±10.3	71.7-83.3	.055	-1.8

SD: Standard deviation, CI: Confidence Interval, Diff: Difference. ANT: Anterior, PM: Posteromedial, PL: Posterolateral, IL: Inferolateral, SL: Superolateral, Max %: Maximum reach percentage.

The descriptive statistics of FMS^{TM} tests of bodybuilders are presented in Table 3. In bodybuilders during the definition period, the mean FMS^{TM} score is 12.7±2.0, the highest score is trunk stability push-up with 2.25±0.96, and the lowest score is rotary stability with 1.42±0.52.

Table 3.

FMS^{TM} test scores of bodybuilders

	Mean ± SD	Max	Min	%95 CI
Deep squat	2.1±0.5	3.0	1.0	1.8 – 2.4
Hurdle step	1.6±0.5	2.0	1.0	1.3 – 1.9
In-line lunge	1.9±0.5	3.0	1.0	1.6 – 2.2
Shoulder mobility	1.8±0.9	3.0	1.0	1.3 – 2.3
ASLR	1.8±0.6	3.0	1.0	1.5 – 2.1
Trunk stability push-up	2.3±1.0	3.0	0.0	1.7 – 2.9
Rotary stability	1.4±0.5	2.0	1.0	1.1 – 1.7
FMS TM composite score	12.7±2.0	16.0	9.0	11.6 – 13.8

SD: Standard deviation, Max: Maximum, Min: Minimum, CI: Confidence Interval.

The relationship between the participants' FMS^{TM} test score with dynamic balance composite scores and static balances is presented in

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Table 4, separately on the dominant and non-dominant sides. There was a significant negative relationship between dominant leg static balance and rotary stability (r=-.832, p=.040, very high correlation), and a significant positive relationship between dominant and non-dominant leg dynamic balance and rotary stability (dominant side: r=.589, p=.044, moderate correlation, non-dominant side: r=.775, p=003, high correlation). There was no significant relationship between upper extremity dynamic balance composite scores and FMS^{TM} scores on both sides of bodybuilders in the definition period.

Table 4.

The relationship between balance and FMS^{TM} test scores in bodybuilders

	Static balance				YBT-LQ				YBT-UQ			
	Dominant		Non-dominant		Dominant		Non-dominant		Dominant		Non-dominant	
	r	p	r	p	r	p	r	p	r	p	r	p
Deep squat	-.127	.810	-.085	.872	.165	.609	.337	.284	-.117	.718	-.132	.682
Hurdle step	.074	.890	-.541	.267	.204	.525	.069	.831	.211	.511	-.009	.976
In-line lunge	-.625	.185	-.682	.135	.165	.609	.144	.655	.210	.510	.205	.523
Shoulder mobility	-.068	.898	-.758	.081	.151	.640	.064	.844	.328	.298	.141	.662
ASLR	.427	.398	.022	.967	.119	.713	.157	.626	.362	.248	.372	.234
Trunk stability push-up	-.033	.951	.374	.465	.311	.325	.547	.066	.426	.167	.419	.175
Rotary stability	-.832	.040	-.557	.251	.589	.044	.775	.003	.385	.216	.424	.170
FMS^{TM} composite score	-.077	.885	-.451	.369	.416	.178	.588	.044	.418	.177	.303	.338

Note: In this table, the relationship only between the "composite score" obtained from the dynamic balance tests and the FMS ^{TM} tests and FMS^{TM} score – for dominant and non-dominant sides- is presented.

The significant positive relationship between both PL reach distance and PL maximum reach percentage with rotary stability in dominant leg (respectively, r=.679, p=.015, high correlation, r=.673, p=.017, high correlation). In non-dominant leg, significant positive relationships were found between PL reach distance and PL maximum reach percentage with trunk stability push-up (respectively, r=.598, p=.040, moderate correlation, r=.598, p=.040, moderate correlation), rotary stability (respectively, r=.843, p=<.001, high correlation, r=.840, p=<.001, high correlation), and FMS^{TM} composite score (respectively, r=.652, p=.022, high correlation, r=.708, p=.010, high correlation). In addition, a significant positive correlation was determined between the non-dominant leg PL maximum reach distance and rotary stability (r=.717, p=.009, high correlation). In upper extremity dynamic balance, only a moderately significant positive relationship was determined between the dominant side SL maximum reach distance and hurdle step (r=.586, p=.046).

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Discussion

In this study, it was aimed to determine FMS^{TM} and balance performance in bodybuilders during definition period and to determine the relationship between them. There was a significant negative correlation between dominant leg static balance and rotary stability (r=-.832, p=.040, very high correlation) and a significant positive relationship between dynamic balance and rotary stability in dominant and non-dominant leg (dominant leg: r=.589 , p=.044, moderate correlation, non-dominant leg: r=.775, p=003, high correlation). There was no significant relationship between upper extremity dynamic balance composite scores and FMS^{TM} composite scores on both sides in bodybuilders during the definition period

The number of studies investigating FMS^{TM} and balance in bodybuilders is very limited. In a study, the average number of falls in the bodybuilding group was 9.2±2.38 in static balance compared to fitness group, in all other FMS^{TM} tests except trunk stability push-up, the fitness group had a higher score, while the bodybuilding group had a better performance in dynamic balance (Matuliunas, 2020). Although the static balance performance of the bodybuilders in the definition period in our research was found to be higher (number of falls: 12.2±2.5) compared to this research, it is quite remarkable that half of our athletes could not complete the static balance test because they could not take the static balance starting position. The inability of the athletes to complete the test may have been affected by many factors (maximized muscle volume, reduction of muscle glycogen sources and dehydration of the muscles) that Steele et al. (2019) and Steen (1991) also mentioned. Tafuri et al.(2016) compared FMS^{TM} scores of CrossFit athletes, bodybuilders and professional weightlifters and they have found that CrossFit athletes exhibit high symmetry of fundamental movement patterns. They have found the lowest FMS^{TM} scores in bodybuilders (CrossFit athletes: 15.2±1.7, weightlifters: 14.8±2.0, and bodybuilders 14.2±1.9). In bodybuilders, the highest score was found shoulder mobility 2.8±0.4, the lowest score was found rotary stability 1.8±0.4 and trunk stability push up 1.6±0.8. In our study, although the FMS ^{TM} score was lower in bodybuilders during the definition period, the highest score was found in trunk stability push-up with 2.3±1.0 and the lowest score in rotary stability with 1.4±0.5. Rotary stability seems to be a predictor with low scores for both studies. In our study, it is thought that the low FMS^{TM} score is due to the fact that bodybuilders are in the definition period.

Correlational studies between FMS^{TM} and balance in different sports disciplines show different results. A moderately positive correlation was determined between FMS^{TM} rotary stability with ANT (r=0.37-0.41,

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p<0.007) and PM reach distance (r=0.31, p=0.03) in intercollegiate athletes (Harshbarger et al., 2018). In team sport athletes, a positive correlation was found between FMS^{TM} composite score and dynamic balance (left leg and composite score, male: r=.447; moderate, female: r=.446; moderate) (Kramer et al., 2019). As a result of this research, the authors reported that these two tests can evaluate similar fundamental structures such as dynamic balance and movement coordination. A moderately positive significant relationship was found between FMS^{TM} score with dynamic balance (r^2=36.24, r=0.602, p=0.001) and static balance (r^2=19.62, r=0.443, p=0.001) in adolescent volleyball players (Arazzadeh & Norastch, 2018). In another study, mean FMS^{TM} score was 14.1±2.1, non-dominant dynamic balance 71.4±9.1 and dominant balance 68.9±7.4 in elite volleyball players, but no significant relationship was found between FMS^{TM} and dynamic balance (Pourheydari et al., 2018). But in the research, they showed sample size as a limitation. A significant relationship was found between trunk stability push-up and right leg PM reach distance (r=0.37) and left leg in-line lunge and left leg PM reach distance (r=0.46) in team athletes (Lockie et al., 2015). In a study conducted with soldiers, better performance on FMS^{TM} composite scores was associated with greater ANT reach distance on the YBT (r=0.49, p=0.001) (Teyhen et al., 2014). In our research, it is remarkable that there is a significant relationship between both static balance and dynamic balance performance and rotary stability test. Whether this finding is specific to the discipline of bodybuilding should be clarified by further research. Cook et al. (2014b) stated that the rotary stability test is a complex movement characterized by multi-planar trunk stability, in which upper and lower extremity movements are combined and appropriate neuromuscular coordination is required. The fact that this movement with high neuromuscular coordination has a very low score in the definition period suggests that other coordinative and core tests should be added to the evaluation of athlete performance in addition to the FMS^{TM} test.

Most of the studies sought to answer the following question: Could FMS^{TM} and dynamic balance be predictors of injury? The study comparing whether there is a difference between FMS^{TM} and dynamic balance in soccer players with and without injuries shows that only the dynamic balance ANT reach distance is significantly different between the groups (p=0.035), while FMS^{TM} does not differentiate between the injured and non-injured groups (Morrell, 2012). In FMS^{TM} and balance studies, which predict injury risk and in injured athletes, hurdle step, deep squat and ASLR were emphasized as primary determinants of composite FMS^{TM} score (Armstrong & Greig, 2018). In another study, it was determined that the FMS^{TM} score increased with age in athletes in different age categories, but

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the dynamic balance test did not change, and it was recommended to apply the FMS^{TM} test for the risk of injury (Lisman et al., 2018). The remarkable finding in another study is that the FMS^{TM} composite score (12±4) obtained in soccer players who had ACL rupture and reconstruction 2 – 3 years ago and is now cleared to play is similar to the score we found in bodybuilders during the definition period (Oleksy et al., 2021). In addition to these studies, it has been reported that a low FMS^{TM} score (<14) in professional soccer players has a much higher risk of a serious injury (with specificity of 0.91 and sensitivity of 0.54) (Kiesel et al., 2007). However, Cook et al. (2014b), the founder of the FMS^{TM} test, has a very different view on this issue in their research. Cook et al. (2014b) specifically reported that although a total FMS^{TM} score below 14 predicted high injury risk, a score above 14 did not include low injury risk. They emphasized that strength and conditioning coaches should not neglect other screenings and tests that are specific to the sports discipline and affect athletic performance in the assessment of the injury risk of athletes.

Another test used as a predictor of disability is the dynamic balance test (Chimera et al., 2015; Marcus Lee et al., 2017). Studies show that ≥4cm ANT reach difference in YBT-LQ balance test increases the risk of injury in collegiate athletes (Smith et al., 2015) and composite reach score of ≤89.6% is a predictor of non-contact lower extremity injury in collegiate soccer players (Butler et al., 2013). In the light of these findings, it is accepted that the participants are not at risk of disability with the YBT-LQ balance test scores (ANT reach distance=2.5cm, composite score=94.1) we obtained in bodybuilders in the definition period. However, the FMS test scores of the athletes do not confirm this result. In a limited number of YBT-UQ studies, composite reach score was 84.5±8.3% of limb length in healthy adults (Gorman et al., 2012). In our study, the YBT-UQ composite score of bodybuilding athletes was found to be 75.8±9.8, which is quite low compared to healthy adults.

Conclusion

In recent years, it is seen that the use of screening tests that can determine the injury risk of athletes has increased. Two of these screening tests are FMS^{TM} and balance tests (usually YBT-LQ). Although the number of studies investigating FMS^{TM} and balance performance in different sports disciplines is high, the number of studies examining the relationship between these tests is very few. Additionally to the best of our knowledge, no study to date has directly evaluated a relationship between FMS^{TM} and balance in bodybuilders especially during definition period. Thus, we hypothesized that FMS^{TM} and balance performance were low in

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bodybuilders during the definition period and that there would be a significant relationship between them. In this study, FMS^{TM} composite scores of bodybuilders in the definition period were below the injury risk limit value (=12.7±2.0), but the YBT-LQ performance was within normal limits according to the literature. In addition, in bodybuilders during definition period, the highest score was in trunk stability push-up with 2.3±1.0 and the lowest score in rotary stability with 1.4±0.5. Rotary stability seems to be a predictor with low scores in parallel with previous research. Although there was no significant relationship between upper extremity dynamic balance composite scores and FMS^{TM} scores on both sides of bodybuilders during the definition period, a very low YBT-UQ composite score was detected. It is a very remarkable finding (50% of the participants) that bodybuilders in the definition period experience limitations in their neuromuscular coordination and trunk stability so much that they cannot even take the static balance starting position. Further studies are strongly recommended to clarify the this issue. The biggest limitation of this research is the sample size. Further research is also recommended to investigate FMS^{TM} and balance performance in female bodybuilders and/or different training period (such as bulking or cutting phases). As a result, the FMS^{TM} score is quite low in bodybuilders during definition period, and the increase in static and lower extremity dynamic balance performance may increase the rotational stability score. Bodybuilders are recommended to practice lower extremity static and dynamic balance exercises in addition to training during the definition period.

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Conflicts of Interest

The authors declare that they have no conflict of interest**.**

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