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The correlation between functional movement screen and core stabilization and y balance test in handball players

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ABSTRACT

Aims: The main aim of the study is to put forward correlation between functional movement screen, core endurance and Y balance test assessments in handball players.

Methods: In our study 30 licensed handball player and 30 sedentary young individuals between 18-22 years old took place. Kasari Physical Activity Index was used containing frequency, intensity, time information in order to determine physical activity level of the sedentary group. In all participants, the Illinois Agility Test was used for agility evaluation and the Vertical Jump Test was used for jumping force measurement and flexor endurance, extensor endurance and lateral bridge tests were used for core stabilization evaluation. Dynamic balance was evaluated via Y balance test. Functional movement patterns were evaluated by functional movement screen consisting of 7 subcomponents.

Results: As a result of the evaluations, In the individuals of athletic group, there is identified positive directional correlation between Functional Movement Screen composite score and flexor stability results ($r=0.653$ $p<0.001$), between, Functional Movement Screen composite score and Lateral bridge dominant side scores ($r=0.542$ $p<0.01$), between, FMS composite score and lateral bridge non-dominant side scores ($r=0.374$ $p<0.05$), between, Functional Movement Screen composite score and Extensor endurance scores but when the relationship between Y balance test and Functional Movement Screen was analyzed; no statistically significant relationship was found ($p>0.05$). There was a difference between the results of the Illinois and Vertical Jump Test in the athletic and sedentary groups ($p<0.001$).

Conclusion: While functional movement screen assessments and core stabilization are closely related to each other, these assessments were not found to be associated with Y balance test. Functional movement screen reflects core stabilization but fails to assess dynamic balance.

Keywords: Functional movement, core stability, dynamic balance, handball

INTRODUCTION

Musculoskeletal system injuries are the natural risks of sports. Non-contact injuries account for 20 per cent of sporting injuries that's why, researchers have shown that risk factors of injuries can be determined by identifying abnormal movement patterns, posture asymmetries and balance abnormalities.[1] In the last two decades, sport rehabilitation has shifted from traditional isolated assessment and strengthening to a functional approach that incorporates proprioceptive neuromuscular principles.[2]

Handball is a difficult sport with a high incidence of injury because of fast running, sudden change of direction and throwing movements. Due to the challenging nature of the game handball players experience significant neuromuscular fatigue that may lead to reduced neuromuscular explosive-based performances. Inflammatory responses of the muscle increase with contact in the game and muscle damage is also observed.[3,4] When the incidence of injuries in handball was investigated, it was reported as 0.6 to 4.6 injuries/1000 hours during training and 10.8-73.6 injuries/1000 hours during competitions.[5]

Functional movement is described as movements which that involve many joints and occur in multiple planes.[6] Functional movement components have been defined as flexibility, strength, endurance, proprioception, range of motion and core stability.[7] Functional assessment is used so as to determine the deficiencies in the basic movement models necessary for the realization of sport-specific skills and especially, to identify potential risks of the injuries of

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musculoskeletal system8. Functional movement assessments should be evaluated with holistic assessment methods that evaluate every plan of the emerging movement, taking into account all parameters affecting the quality of the movement.

One of the tests used for functional assessment is functional movement screen. FMS tests are constructed based on basic proprioceptive and kinesthetic awareness principles. Each test is a specific movement that requires the appropriate function of the body's kinetic linkage system.[2] Functional movement screen is a battery of seven movement task tests assessed by visual observation using standardized criteria.[9]

Balance is a result of somatosensory, visual, vestibular, musculoskeletal and central nervous system activation working together10,11. Although balance is thought as a static process, it is a set of dynamic process including many neurological pathways.[10] Y balance test (YBT), which is prepared by modifying the star balance test, is described as a way which is pratic and easy in the name of the assessment of dynamic capacity in order to protect balance. For this reason, this test has found wide application in sports rehabilitation.[12]

The "core", also called the lumbopelvic-hip complex, is a 3-dimensional space with muscular boundaries. These boundaries are: the diaphragm (upper), the abdominal and oblique muscles (front-side), the paraspinal and gluteal muscles (back) and the pelvic, floor and hip girdle (lower). The natural structure of these muscular boundaries creates a corset-like stabilizing effect on the trunk and spine.[13] A weak core region brings about changes in energy transfer, and this also causes the falling of sport performance and risk of injury of weak or underdeveloped muscle group14. Core stabilization tests is used so as to put forward relationship between core stabilization and performance. It is described 35 different tests about core stabilization and is categorized in five different group. These groups are generally, expressed as strength, endurance, flexibility, motor control and function.[15] The basic stability tests commonly used by clinicians are right and left lateral bridge and flexor endurance test16.

Recent studies have focused on assessing functional movement patterns in athletes rather than isolated assessments. Handball also involves many functional movement patterns. The aim of this study was to determine the relationship between functional movement screen and core endurance and Y balance test evaluations in young handball players with objective data.

METHODS

In our study 30 licensed handball player and 30 sedentary young individuals between 18-22 years old took place. Inclusion criteria were being licensed handball player or sedentary volunteer and not having been undergone a surgical operation involving the musculoskeletal system in the last six months. Demographics such as occupation, age, gender, dominant hand, height, body weight, body mass index were obtained in the participant evaluation form.

The ethics committee approval of our study was obtained with the decision of Süleyman Demirel University Faculty of Medicine Clinical Researches Ethics Committee dated 21.12.2020 and numbered 399. Participants were included in the study after consent forms were obtained. All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

Participants are evaluated with Kasari Physical Activity Index. According to the Kasari score, physical activity level is commented as sedentary between 0-20, poor between 21-40, normal between 41-60, good between 61-80 and perfect between 81-10017,18.

Illinois agility test is used for agility assessment in which the athletic's agility abilities are measured in the region which possesses a size of 10×5 m. The completion time of the prepared track was recorded with a stopwatch. In our study, this distance was set as 10 m. The test area was marked with four centre cones spaced 3.3 m apart and four corner cones placed 2.5 m away from the centre cones. The individual started the test lying prone on the ground behind the starting line with arms at the side and head in front. The individual was asked to run as fast as possible and to change direction quickly.[19]

Vertical jump test is used for jumping force measurement, and firstly for this test, the height at which the person turned sideways to the wall and extended his/her arm was marked. Secondly, he/she was asked to jump as high as possible and the height at which he or she jumped was read again on the tape measure. The difference between the first point and the last point was recorded as the jump height. Three trials were performed and the highest value was taken into account.[20]

Core Stabilization Tests: The flexor muscle endurance test is initiated with the subject in a sitting position, with the back leaning against an apparatus angled 60 degrees from the floor. Both knees and hips are flexed to 90 degrees and the support apparatus is withdrawn and the time the person maintains the position is recorded.[21] The extensor muscle endurance test is performed with the upper trunk extended towards the end of the bed on which the test is performed and the pelvis, knees and hips fixed. The time the upper trunk maintains its level is recorded.[21] The lateral bridge test was performed with the individual lying in the full side bridge position (left and right side separately). Individuals supported themselves on one elbow and their feet while lifting their hips off the floor to form a straight line from head to toe. The test was terminated when the individual lost the straight back posture and/or their hips touched the floor.[21]

YBT, which is performed in the standing position on one leg, is a dynamic a test. Participants stood on the footplate in the centre of the Y Balance Test area and then, it was given instruction them that they should maintain a single leg stance while reaching as far as possible with the opposite leg and return to the starting position on the center platform without losing balance. In the test, individuals were asked to reach the maximum distance in 3 directions (anterior, posteromedial and posterolateral), allowing 3 trials for each leg. The maximum reach distance was recorded for each consecutive trial.[22]

FMS consists of seven test component which are used to evaluate various main movement models. Individuals completed one by one deep squat, high stepping, single line lunge, shoulder mobility, straight leg raises, trunk stability push-ups, rotation stability which are the components of the tests battery. Subcomponent tests assess asymmetry by measuring the individual bilaterally. Each component test was scored on an ordinal scale (0 to 3 points), with a maximum score of 3, based on the quality of the movement. Less than 3 points indicated that the individual performed some form of compensation or was unable to complete the entire movement. While individuals were doing these tests, they were recorded in the video, the final scoring was done by evaluating the images. The scores of the component tests were summed, resulting in a composite score between 0 and 21 points, with a maximum score of.[21-23]

Mean Standard Deviation and Median values were given in descriptive statistics for continuous data, and number and percentage values were given in discrete data. Shapiro-Wilk test was used to examine the conformity of continuous data to normal distribution. In the comparisons of continuous variables between athletic and sedentary groups, the independent samples t test was used for the data fitting the normal distribution and Mann Whitney U test was used for the data not fitting the normal distribution. The relationships between the scales were analyzed with Spearman's correlation coefficient. IBM SPSS Statistics 20.0 program was used in the evaluations and p<0.05 was accepted as the statistical significance limit.

RESULTS

In this study, the correlation between FMS and core stabilization and Y balance test was revealed. The mean age of the athletics participating in the study was 22.06±1.48 years, mean height 182.33±5.89 cm, mean weight 77.23±8.33 kilograms, and mean body mass index 23.21±1.52 kg/m2. The physical characteristics of the athletic and sedentary groups are shown in Table 1.

Table 1. Comparison of physical characteristics of individuals in athlete and sedentary groups

	TOTAL	ATHLETE	SEDENTARY
	x̄±SS Median (Min-Max)	x̄±SS Median (Min-Max)	x̄±SS Median (Min-Max)
AGE	21 (19-25)	21 (21-25)	20 (19-21)
HEIGHT	181.60±6.28	182.33±5.89	180.86±6.66
WEIGHT	79.5 (53-93)	78 (53-93)	80.5 (64-90)
Body-Mass-Index	23.95(18.13-27.02)	23.44(18.13-25.49)	24.43(22.45-27.02)

There was a statistically significant difference between the results of the Illinois and Vertical Jump Test in the athletic and sedentary groups (p<0.001). There was no difference between the results of the Y right and left anterior balance test of the individuals in the athletic and sedentary groups (p>0.05). There was a statistically significant difference between the Y right-posteriolateral and Y right-posteromedial reaching distances of the individuals in the athletic and sedentary groups (p<0.001). A statistically significant difference was found between the Y left-posteriolateral and Y left-posteromedial reach distances of the athlete and sedentary groups (p<0.001) (Table 2).

There was a difference between the results of flexor muscle endurance test, lateral bridge tests, extensor muscle endurance test of the individuals in the athletic and sedentary groups (Table 2).

When the total score and subcomponents of functional movement screen in athletic and sedentary groups were analyzed, a significant difference was found in all subcomponents except deep squat and stability push-up (p<0.001) (Table 3).

In individuals of athletic group, it was not found correlation between FMS points and Y balance test. (p>0.05) (Table 4). In individuals of athletic group, a positive correlation between FMS scores and flexor endurance results (r=0.653 p<0.001), FMS scores and Lateral bridge dominant side scores (r=0.542 p<0.01), FMS scores and lateral bridge nondominant side scores (r=0.374 p<0.05), FMS scores and extensor endurance scores (r=0.511 p<0.01) was found. (Table 4).

DISCUSSION

IIn our study, while there is found significant correlation between FMS and core stabilization, no relationship is found between FMS and YBT. Though functional movement screen is a test battery that evaluates many parameters, it is considered to be insufficient in the overall assessment of athletic performance.

Athletics have different requirements in each age group. The maturation and growth process basically brings anthropometric and then psychological changes. Sportive assessment and programs should be made according to age groups by taking these changes into consideration. Exercise programs, which are applied without paying attention the difference of age group, decrease effectiveness. This condition is more common in amateur and regional teams24. When elite and amateur level handball players are compared, it is revealed that elite level players have better agility, aerobic capacity and lower limb muscle strength20. This suggests that

Table 2. Comparison of Illinois, Vertical Jump, Y Balance Test results of athletes and sedentary groups

	TOTAL	ATHLETE	SEDENTARY		
	x̄±SS Median (Min-Max)	x̄±SS Median (Min-Max)	x̄±SS Median (Min-Max)	Test Statistic	p
İllinois	24.76±6.13	19.26±1.17	30.26±3.54	t=-16.127	<0.001*
Vertical Jump	28.66±6.04	33.67±3.32	23.66±3.37	t=11.576	<0.001*
YBT right-anterior	79.98±11.91	82.39±9.83	77.52±13.42	t=1.586	0.118
YBT right-posteriolateral	95.02±15.84	105.16±10.85	84.88±13.42	t=6.433	<0.001*
YBT right-posterio medial	91.17±15.85	101.96±9.48	80.38±13.44	t=7.182	<0.001*
YBT right-anterior	79.03±11.66	80.57±10.31	77.48±12.85	t=1.026	0.309
YBT left-posteriolateral	90.87±14.25	101.53±10.26	80.22±8.54	t=8.738	<0.001*
Y left-postero medial	88.44±15.33	98.92±10.04	77.96±12.26	t=7.241	<0.001*
Flexor endurance	91.15 (68.7-128)	99.1 (86.3-128.1)	79.5 (68.7-91.5)	U=6.5	<0.001
Lateral bridge Dominant	22.4 (19.5-40.8)	24.5 (20.2-40.8)	22 (19.5-28.3)	U=216.0	<0.001
Lateral bridge nondominant	21.2 (17.3-37.4)	22.3 (18.2-37.4)	20.9 (17.3-26.2)	U=287.5	0.016
Extensor endurance	94.28±31.36	124.17±10.18	64.39±7.06	t=26.428	<0.001

U: Mann Whitney U test t: Student t test (Independent samples t test)
*: The p value is less than 0.05 in the Independent-sample t Test and Mann Whitney U Test
Abbreviations: YBT, Y balance test

Table 3. Comparison of FMS scores of individuals in athlete and sedentary groups

	TOTAL	ATHLETE	SEDENTARY		
	x̄±SS Median (Min-Max)	x̄±SS Median (Min-Max)	x̄±SS Median (Min-Max)	Test Statistic	p
Deep Squat	2 (1-3)	2 (1-3)	2 (2-3)	U=400.5	0.387
Right High step	3 (1-3)	3 (2-3)	2 (1-3)	U=295.0	0.009*
Left High step	2 (1-3)	3 (2-3)	2 (1-3)	U=287.5	0.007*
Right Single line lunge	2 (1-3)	2 (1-3)	2 (1-3)	U=258.5	0.001*
Left Single line lunge	2 (1-3)	2 (1-3)	2 (1-2)	U=302.0	0.009*
Right shoulder mobility	3 (2-3)	3 (2-3)	2.5 (2-3)	U=270.0	0.001*
Left shoulder mobility	3 (2-3)	3 (2-3)	2 (2-3)	U=240.0	<0.001*
Right straight leg raise	3 (2-3)	3 (2-3)	2 (2-3)	U=135.0	<0.001*
Left straight leg raise	3 (1-3)	3 (2-3)	2 (1-3)	U=103.5	<0.001*
Stability push-ups	3 (2-3)	3 (2-3)	2.5 (2-3)	U=345.0	0.065
Right rotation stabilization	2 (1-3)	2 (1-3)	2 (1-2)	U=292.0	0.003*
Left rotation stabilization	2 (1-3)	2 (1-3)	1.5 (1-2)	U=315.0	0.020
FMS Compozit Score	16 (12-19)	18 (15-19)	15 (12-17)	U=47.5	<0.001*

U: Mann Whitney U test t: Student t test (Independent samples t test)
*: The p value is less than 0.05 in the Independent-sample t Test and Mann Whitney U Test
Abbreviations: FMS, functional movement screen

Table 4. Relationships between FMS scores and Y balance test and Core stabilization scores in the athlete group

	FMS Composit	
	r*	p
YBT right-anterior	0.211	0.264
YBT right-posteriolateral	0.119	0.531
YBT right-posteriomedial	0.132	0.487
YBT left-anterior	0.198	0.295
YBT left-posteriolateral	0.009	0.963
YBT left-posteriomedial	0.020	0.916
Flexor endurance	0.653	<0.001*
Lateral bridge Dominant	0.542	0.002*
Lateral bridge nondominant	0.374	0.044
Extansor endurance	0.511	0.004*

* Spearman's Correlation Coefficient
*: The p value is less than 0.05 in the Spearman's Correlation
Abbreviations: FMS, functional movement screen; YBT, Y balance test

biomechanical assessment is more essential in young amateur players.

Usual typical procedures are inadequate in order to evaluate the physical requirements of young persons objectively. The tests, which include core stability and functionality in addition, are more successful. Compensatory movements in the basic movement patterns have been identified as an important risk factor of injury in athletics. FMS is an effective test battery that reveals the weakness of movement patterns.[25] In a meta-analysis examining injury mechanisms with FMS, a composite score of less than 14 points and the presence of asymmetry were found to be an injury risk. Its sensitivity was found to be high in predicting non-traumatic (non-contact) injuries in athletics.[26] The injury evaluation of team sports and precaution programs should be dynamic a process in other words the process should consist of continuous re-evaluation.[22] Identifying the deficiencies and asymmetries in the functional movement patterns of young athletics before entering professional life can enable the athletic to reach functional competence by selecting the appropriate rehabilitation program.

In the beginning of the season, young handball players, who are evaluated with FMS, do not experience injury during the season after locomotor exercises for the determined body asymmetries.[22] Regular FMS assessment in training programs will have an important place in injury prevention by revealing risk factors.

The demographic qualities of athletics and sedentary groups, who participated in the study, show similarity. The athletic group indicated better performance than the sedentary group in both vertical jump distance and agility test times. The fact that the athletic group had a training period of at least 4 days per week can be considered as the main reason for this difference. When the reaching distances of athletic university students and sedentary university students in the Y balance test were compared, athletic students showed better performance in all directions.[27] The athletics in our study demonstrated better performance in posteromedial and posterolateral directions compared to sedentary individuals, while no significant difference was found in the anterior direction. The Y balance test requires good knee stabilization and quadriceps muscle strength during anterior reaching.[28] We think that our young athletics are open to improvement in terms of structures that provide knee stabilization.

There was founded different average datas in the studies which are done for functional movement screen. In a study of 209 young individuals who did sports for at least 30 minutes 2 days a week, the mean composite score was calculated as 15.7 points.[29] In a study with healthy adults, 622 individuals participated and the mean composite score was found to be 14.1430. In our study, the mean composite score was calculated as 17.56. Young individuals had higher composite scores than adult ones, age factor and the fact that young people had better biomechanical alignment might be effective in this situation. So as for the use of FMS to become widespread, normative values by age groups should be clearer.

Functional movements substantially are used during both daily and sport activity. Core stabilization and dynamic balance are factors, which determine the quality of functional movements. Postural stability is an essential a component of functional movement. Lumbar stability is closely related to performance in overhead shooting athletics. Proximal stabilization through the abdominal fascial system has a direct effect on upper limb stability31. Handball players with higher core power and endurance, they have better shooting performance and are less likely to suffer upper limb injuries.[30]

FMS all alone may be insufficient to predict the performance therefore it is recommended to be used in combination with other tests. Core stability plays an essential a role in the elicitation of functional movement.[33] Many studies in the literature have supported our findings by showing that core stabilization and functional movement screen results are related. Even if players have good coordination, reduced core stabilization ability will affect their functional movement patterns. Core stabilization plays an important role in the transfer of force to the terminal segments in both basic and functional movement.

Since handball is defined as a sport, which requires so much effort, it increases the risks and it becomes clear that the assessment should be made with a holistic approach. In handball, the finding of asymmetry between the extremities as a result of the y balance test negatively affects the vertical jump strength of the athletes.[34] Y balance test performance is directly affected by trunk and lower extremity kinematics. Dynamic postural control depends on trunk and limb alignment.[35] No strength correlations were discovered when relations between Y balance test and FMS were examined. Reach distances in the Y balance test and FMS composite scores were analyzed in a study of 78 individuals and no significant relationship was found. FMS is often used to identify weaknesses, asymmetries and compensatory movement patterns that can be corrected through exercise training. It is difficult to capture all aspects of dynamic postural control with one component of the FMS.[36] In our study, no significant correlation was found between Y balance test and FMS composite score. Functional movement screen is insufficient in the assessment of dynamic balance. Because ıt belongs to a evaluation scale on protecting the biomechanical movements performed in the subcomponents of FMS, it better reflects static balance.

In a study evaluating the relationship between the Y balance test and the subcomponents of the FMS test battery, no significant relationship was found between the Y balance test and the subcomponents of the FMS test battery.[37] FMS is insufficient to assess dynamic balance. In the evaluation of functional movement patterns, dynamic balance tests should be included in addition to FMS.

The fact that our study is the first application of FMS in amateur handball players in the 18-25 age group stands out as the strength of our study. The limitations of our study are that only male athletes were included, and a power analysis to determine the sample size could not be performed because a similar study had not been published before.

CONCLUSION

When the relationship between FMS and Y balance test was analyzed; no relationship was found. When the relationship between FMS and core stabilization was examined; a significant relationship was found between the FMS composite score and the endurance tests used for core stabilization. Positive correlation was found between FMS scores and flexor stability, lateral bridge dominant, lateral bridge non-dominate, extensor endurance test results in the athletic group.

Since handball consists of too much functional pattern, evaluation should make by taking this into account. During the assessment, risk factors and biomechanical mechanisms that may pose a risk should be identified. In addition to the classical injury risks described in the literature, individual functional risk factors should also be described. Neurodynamic and biomechanical malalignment of the trunk and lower limbs can lead to pathologies that may prevent functional movement. Reduced postural control will make it difficult to maintain the centre of gravity within the surface of the support under dynamic and static conditions and increase the risk of injury. The application of functional movement assessment with core stabilization and balance assessments will reveal biomechanical or neuromuscular pathologies.

ETHICAL DECLARATIONS

Ethics Committee Approval: The study was carried out with the permission of Süleyman Demirel University Faculty of Medicine Clinical Researches Ethics Committee (Date: 21.12.2020, Decision No: 399).

Informed Consent: All patients signed and free and informed consent form.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

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