THE RELATIONSHIPS BETWEEN THE FUNCTIONAL MOVEMENT SCREEN AND THE POSTURAL STABILITY IN COLLEGIATE ATHLETES

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The Functional Movement Screen (FMS) is a tool developed recently not only to aid in the prevention of injury by objectively measuring dysfunction and asymmetries within movement patterns, but also could be used as a baseline for further strength, conditioning, or athletic development. The purpose of this study was to examine the relationships between the scores of FMS in relation to the postural stability (PS) in collegiate athletes. A total of 30 male, basketball athletes volunteered to join this study. The PS were measured by the Biodex Balance System as the displacements of the center of foot pressure (COP) in the limits of stability. The score of FMS were evaluated by one certified professional experts. The results showed that the score of FMS has relation to the performance of the PS in a certain extent, especially in the FMS-shoulder mobility to the LOS overall level 6 (r=.26-.41), in the FMS-active straight leg raise to the LOS forward, backward, right, right-back level 6 (r=.30-.39), and in the FMS-trunk stability push-up to the LOS right, back, and right-forward. It was concluded that the score of FMS might be used to evaluate and/or predict the performance of the PS in young, collegiate athletes.

KEY WORDS: exercise training, balance, center of pressure, body control.

INTRODUCTION: The Functional Movement Screen (FMS) was developed by Dr. Cook (Cook, Burton & Hogenboom, 2006a & 2006b), which consists of 7 different body movements to assess the following: trunk and core strength and stability, neuromuscular coordination, asymmetry in movement, flexibility, and dynamic flexibility etc. The FMS evaluate the efficiency of movement patterns rather than the quantity of repetitions performed or the amount of weight lifted. It measures the quality of the movement based on specific criteria and identify asymmetry in one's selected test movements in given quantitative values for the movement on a scale of 0-3. Moreover, the FMS is more specific-target profession that other field and/or fitness tests (Beckham & Harper, 2010). Furthermore, The FMS not only provides a visual-identification score guidance and immediate feedback, but also can be easily administered in all kinds of facilities and environments, therefore it is a simple, rapid, noninvasive, and inexpensive evaluation methods for physical condition and training program. The aim of this study was to examine the relationships between the scores of FMS in relation to the postural stability (PS) in collegiate athletes.

METHODS: Thirty healthy collegiate male students (height: 175.1 ±6.9 cm, mass: 67.4 ± 11.2kg, age: 21.5 ± 1.9 yrs) from National TsingHua University, Taiwan, participated in this study. All participants completed a self-report health history questionnaire and signed a written informed consent before testing.
The postural stability (PS) was evaluated by the 8-direction limits of stability (LOS) test. Subjects were tested bilaterally at two levels of difficulty: 3 and 6. To control for the learning effect and fatigue, the order of the tests was randomly assigned. The subject was instructed to start moving the cursor which accurately moves the display toward the flashing target at eight different directions. The LOS score was calculated for each direction according to the percentage between the straight line distance to target and the number of samples. This test challenges subjects to move and control their center of gravity within their base of support. During each test trial, subjects must shift their weight to move the cursor from the center to a random-selected target and back as quickly and with as little deviation as possible (Clark,

Rose, & Fujimoto, 1997). Therefore, the less the centre of mass path takes to the target and back to center, the higher the score will be achieved.
The FMS was performed by a certified exercise instructor whom completed FMS level 1 Certification and had passed their FMS online certification test. Three pieces of equipment: a measuring device, a measuring stick and a hurdle, were used to evaluate each subject's FMS scores. The 7 different movement test of FMS: deep squat (DS), hurdle step (HS), incline lunge (ILL), shoulder mobility (SM), active straight leg raise (ASLR), trunk stability push-up (TSPU), and rotary stability (RS), were fully described and performed before each test. Then, each subject was assessed on their performance and a score was given to the movement based on specific FMS criteria. A score of 3 indicates that the movement was completed both pain-free and without compensation. A score of 2 indicated that the movement was completed pain-free but with some level of compensation or aid, and a score of 1 indicated that the client could not perform the movement. A score of 0 was assigned to a movement that induced pain. When FMS is performed, 5 of the 7 tests (HS, SM, ASLR, TSPU, and RS) are scored independently on the right and left sides of the body. Because of the relationship between neuromuscular asymmetry and injury risk, the FMS scoring system highlights asymmetry and takes the lowest score of 2 as the overall score for that movement. For example, an active straight leg raise score of 3/3 on the left leg and 2/3 on the right gives an overall score of 2/3 on the active straight leg raise movement. No complications or adverse events that occurred during test and/or while collecting the data. Pearson product correlation analysis were used to analyze the correlations between the scores of FMS in relation to the performance of the PS in collegiate athletes.

RESULTS: The descriptive statistics for LOS performances at level 3 and at level 6 were listed in Table 1. The summary of the Pearson product correlation between the scores of FMS and the performance of LOS at level 3 and level 6 were listed in Table 2 and Table 3. There were significant correlations between the score of FMS and the performance of the PS in a certain extent, especially in the FMS-trunk stability push-up to the LOS right, back, and right-forward at level 3 (r=-.30~-.27, Table 2), in the FMS-shoulder mobility to the LOS overall at level 6 (r=-.25~-.41, Table 3), in the FMS-active straight leg raise to the LOS forward, backward, right, right-back at level 6 (r=-.30~-.39, Table 3).

Table 1
Descriptive statistics for LOS performances in level 3 and level 6.

LOS Directions	Level 3	Level 6
Overall	18.75±9.71	24.25±11.25
Forward	23.20±15.75	30.40±13.85
Backward	27.30±15.60	24.90±10.53
Right	26.60±13.00	30.10±14.06
Left	25.00±15.32	34.30±15.30
Right-forward	22.00±11.25	29.50±13.63
Left-forward	24.40±14.03	30.10±14.67
Right-backward	28.70±11.70	31.65±13.32
Left-backward	22.70±12.22	24.65±13.48

Table 2
Pearson correlation matrix for the scores of 7 tests of the FMS and the performance of the LOS at level 3

	DS	**HS**	**ILL**	**SM**	**ASLR**	**TSPU**	**RS**
O	-0.13	0.00	-0.03	-0.09	-0.07	-0.14	-0.05

F	-0.07	-0.02	-0.03	-0.09	0.04	0.08	-0.01
B	-0.21	0.22	0.25	-0.05	0.06	-0.27*	-0.09
R	0.07	-0.06	-0.15	-0.03	0.08	-0.30*	-0.08
L	-0.08	-0.13	-0.08	0.11	0.04	0.07	-0.17
RF	-0.14	0.05	0.21	-0.21	-0.25	-0.30*	0.05
LF	0.00	-0.04	-0.15	-0.06	-0.04	-0.03	-0.14
RB	0.01	0.08	-0.03	-0.14	-0.01	-0.05	0.02
LB	-0.02	0.00	-0.04	0.00	-0.08	-0.20	-0.19

Abbreviations: O: overall. F: forward, B: backward, R: right, L: left, RF: right-foward, RB: right-backward, LF: left-forward, LB: left-backward, DS: deep squat, HS: hurdle step, ILL: inline lunge, SM: shoulder mobility, ASLR: active straight leg raise, TSPU: trunk stability push-up and RS: rotary stability.

Table 3
Pearson correlation matrix for the scores of 7 tests of the FMS and the performance of the LOS at level 6

	DS	HS	ILL	SM	ASLR	TSPU	RS
O	0.07	-0.13	0.08	-0.27*	-0.18	-0.01	0.02
F	-0.11	-0.13	0.34	-0.37*	-0.33*	-0.10	-0.16
B	0.03	-0.16	0.35	-0.26*	-0.39*	-0.09	-0.09
R	-0.19	-0.32*	-0.02	-0.29*	-0.32*	0.09	-0.01
L	-0.05	0.04	0.17	-0.41*	-0.06	-0.03	0.20
RF	0.10	-0.13	-0.02	-0.28*	-0.09	0.16	0.10
LF	0.01	-0.10	0.20	-0.26*	-0.17	0.04	-0.09
RB	0.07	-0.07	0.10	-0.25*	-0.30*	-0.20	0.03
LB	0.38*	-0.11	0.04	-0.27*	-0.16	0.11	0.01

Abbreviations: O: overall. F: forward, B: backward, R: right, L: left, RF: right-foward, RB: right-backward, LF: left-forward, LB: left-backward, DS: deep squat, HS: hurdle step, ILL: inline lunge, SM: shoulder mobility, ASLR: active straight leg raise, TSPU: trunk stability push-up and RS: rotary stability.

DISCUSSION: The primary purpose of this study was to determine the relationships between the scores of functional movement screen and the performance of the postural stability in collegiate basketball athletes. We assessed postural stability through tests that elicited static and dynamic balance control and neuromuscular contractions of the trunk musculature (Lee & Lin, 2008; Lin, Liu, Hsieh & Lee, 2009). Functional movement is the ability to produce and maintain a balance between mobility and stability along the kinetic chain while performing fundamental patterns with accuracy and efficiency (Wang, Lin, Huang, Liang & Lee, 2012), which was assessed with Cook's FMS.
Only negative correlations (-.25~-.41, Table 2 & Table 3) were identified between the scores of FMS and the performance of LOS indicated reasonable well, because the larger FMS and/or LOS scores mean poor performances in functional movement and/or postural stability control. The assessment of fundamental movements is an attempt to pinpoint deficient areas of mobility and stability that may be overlooked in the asymptomatic active population.

The TSPU tests the ability to stabilize the spine in an anterior and posterior plane during a closed-chain upper body movement, and assess trunk stability in the sagittal plane while a symmetrical upper-extremity motion is performed. This study showed that the score of the FMS-TSPU has relationship to the performance of LOS right, back, and right-forward at level 3 (r=-.30~-.27, Table 2), which demonstrated that subject with well trunk stability could control their postural stability much better during the dynamic balance testing. Many functional activities in sport require the trunk stabilizers to transfer force symmetrically from the upper extremities to the lower extremities, such as rebounding in basketball, overhead blocking in volleyball, or pass blocking in football. If the trunk does not have adequate stability during these activities, kinetic energy will be dispersed and lead to poor functional performance (Cook, Burton, & Hogenboom, 2006b).

Moreover, The SM assesses bilateral shoulder range of motion, which combining internal rotation with adduction and external rotation with abduction. The test also requires normal scapular mobility and thoracic spine extension around the shoulder region. This study showed the score of the FMS-SM has relationship to the performance of LOS overall and all the other directions at level 6 (r=-.25~-.41, Table 3), which demonstrated that well shoulder mobility could be very important for athletes in order to proper control their postural stability during the postural balance testing..

Furthermore, the ASLR tests the ability to disassociate the lower extremity from the trunk while maintaining stability in the torso, therefore, can assesses active hamstring and gastroc-soleus flexibility while maintaining a stable pelvis and active extension of the opposite leg. This study showed the score of the FMS-ASLR has relationship to the LOS forward, backward, right, right-back at level 6 (r=-.30~-.39, Table 3) which demonstrated that well flexibility of athlete's lower extremities might be another important factor to proper control their postural stability during static balance testing. The ability to perform the active straight leg raise test requires functional active hamstring flexibility, which is different from passive flexibility, because the athlete is required adequate hip mobility of the opposite leg as well as lower abdominal stability.

CONCLUSION: The score of FMS has relation to the performance of the PS in a certain extent, especially in the FMS-shoulder mobility, active straight leg raise, and trunk stability push-up. This study demonstrated that the score of FMS might be used to evaluate and/or predict the performance of the PS in young, collegiate athletes.

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