FUNCTIONAL MOVEMENT SCREEN PREDICTORS: CAN HIGH FMS SCORES BE PREDICTED THROUGH RANGE OF MOTION, STRENGTH, AND BALANCE MEASURES?

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Background

There has been a steady increase in sport participation in the U.S. over the recent years, and with increases in activity comes a rise in the physical demands of sport on the musculoskeletal system. These demands coupled with increased sport activity can yield an increase in the risk of injury. Functional movement occurs in everyday life, and even more so in an athletic population. When these movements are imbalanced or biomechanically inefficient, breaks in the proper kinetic chain of movement will begin to occur. Compensatory movement will follow the bodies physical deficits, so early detection or proper intervention are important. During activity the human body will initiate movement through the path of least resistance; meaning inefficient functional movement can increase chances of acute injury through compensatory musculoskeletal activation or lead to microtrauma through the wear and tear of joint tissues from repeated improper fundamental movement of the musculoskeletal system. If problems exist with one link of the kinetic chain, problems are then carried to the following link; this forces the second link to alter its normal function in the activated kinetic chain.

The Functional Movement Screen (FMS) is a movement test that incorporates essential functional movement patterns and categorizes an individual's efficiency to complete them on an ordinal scale in an attempt to predict an individual's readiness to safely engage in activity or sport. If outcomes could be predicted using physical measures, health professionals would be able to quickly predict an individual's score for the FMS. Showing predictive physical measures that test the requirements of an FMS would allow the ability to increase specificity of training programs aimed at increasing functionality. When an individual increases their capability to produce correct functional movement they decrease their risk of injury, so it would be possible that by increasing a programs ability to produce such movement by focusing on deficits in the predictive areas we can decrease their risk for injury. Also, if the FMS were predictable untrained individuals in FMS assessment could assess functionality. To our knowledge no current research has attempted to find predictive measures of performance on a FMS.

Purpose

The purpose of this study was to explore what physical measure(s) [e.g., range of motion, strength, balance] can best predict high scores in a Functional Movement Screen (FMS).

Methods

Subjects reported on two different days using the protocol outlined below. First each subject arrived at Texas Metroplex Institute (TMI) and read and signed an informed consent document. The subjects were screened for health history, history of musculoskeletal injury, and history of musculoskeletal pain with a written health history questionnaire. Each subject completed the hand written informed consent document and health history questionnaire previous to testing. Subjects with any macrotraumatic musculoskeletal injuries within the previous year were excluded. Those with approved previous injury were asymptomatic to pain in the area of injury. 24 individuals completed a FMS, but due to scheduling conflict only 20 completed all testing (age: 20.2±1.5 yrs; ht: 170.7±13.4cm; wt: 150.8±24.4kg) 8 females (age: 19.5±1.1 yrs; ht: 166.5±12.8cm; wt: 132.7±17.6kg) and 12 males (age: 20.7±1.6 yrs; ht: 173.6±13.6cm; wt: 162.8±20.7kg). At TMI subjects received a FMS from a certified FMS tester. Once completed, all subjects met at the University of Texas Arlington Neuromuscular Research Laboratory. All subjects were asked to abstain from alcohol consumption within 48 hours of testing. Upon arrival the subjects completed a Dizziness Handicap Inventory (DHI) and an Activities-specific Balance Confidence (ABC) Scale to ensure they were in an acceptable state to be assessed for balance efficiency. All subjects that reported a 94% or less on the ABC Scale or indicated a positive response to any DHI questions were excluded. All remaining measures were taken after each subject's questionnaires were approved. These included ROM, strength, and balance.

Methods (cont'd)

Day One: Upon arrival at TMI a FMS test kit that included a measuring device, hurdle, and measuring stick were used to conduct each individual's FMS by a certified FMS tester. The FMS is a quantifiable test consisting of 7 different movement patterns that were added for a composite score, and are considered to be a comprehensive understanding of the individuals efficiency of functional movement. The 7 movements tested in the assessment included: the deep squat, the hurdle step, the in-line lunge, the shoulder mobility test, the active straight leg raise, the trunk stability push-up, and the rotary stability test. There were 3 clearing tests completed during assessment which were individually associated with a specific FMS test, and was used to check for pain that was not apparent in the FMS test. These clearing tests included a shoulder clearing test (shoulder mobility), a spinal extension clearing test (trunk stability push-up), and a spinal flexion clearing test (rotary stability) which was used to attempt to pin point pain in shoulder internal rotation/flexion and end-range spinal flexion and extension. Scoring of the 7 FMS tests was based on a 0-3 ordinal scale. The highest score that can be given for each movement test is a 3 which indicated a functional ability to complete the specified movement as defined by the creators of the FMS. If there was a compensatory action that presented itself during the movement pattern a score of 2 was awarded, and if the subject was unable to complete to movement pattern in any test a score of 1 was awarded. A score of 0 was reserved for those who indicated pain through any portion of a movement. In the clearing tests, a score of -/+ was scored with negative (-) indicating no pain was felt and positive (+) for any indication of pain. If a subject was awarded a positive (+) pain score for any of the 3 clearing tests, the FMS test associated with it was automatically scored a 0 final score for the test regardless of previous performance. The hurdle step test, in-line lunge test, shoulder mobility test, active straight leg raise test, and rotary stability test all included tests of the right and left sides exclusively, and the lower score of the two trials was recorded for the composite FMS score. The highest total score that could be awarded was a 21 while the lowest was a 0.

Day Two: In the laboratory demographic measures were taken upon arrival. The subject was then asked to lay prone on a table and appropriate changes of anatomical position were carried out by the tester when the active range of motion (AROM) measures of the shoulder (abduction, flexion/extension, internal/external rotation), hip (flexion/extension, internal/external rotation), knee (flexion/extension), and ankle (dorsiflexion) were taken. Next muscular strength of the glueteus maximus, gluteus medius, and ankle dorsiflexors was assessed using a Microfet 3 handheld dynamometer using the manufacturers recommended procedures and placement for a "BREAK" test to allow the tester the greatest amount of mechanical advantage. Each muscle was tested 3 times and the highest score was recorded The subject was then moved to the Biodex System 3 where the System 3 was adjusted to individual settings as specified by the manufactures instructions. After verbal instruction of what a maximal effort is, the subject was allowed to have a trial set before each of 2 testing sets (1 set of 5 at 180°/s, 1 set of 10 at 300°/s). During both sets verbal encouragement was offered. The subject was then placed on the forceplate of the Neurocom SMART Balance machine and both feet were aligned using the instructions for each protocol selected. A Sensory Organization Test, Weight Bearing Squat Test, and a Unilateral Sway Test were administered in that order following manufacturers protocols.

Statistical analyses of the data was run with NCSS. Pearson product-moment correlations were run initially to identify any trends in the data, and once these were identified we used a forward stepwise regression analyses to indicate the amount of variance contributed by combinations of the predicting independent variables on different dependent variable splits.

Results

When final FMS scores [14.95±1.4] were split into higher (>15) and lower (≤15) final scores, the following was recorded. Lower FMS scores for all subjects had 4 predictive variables (shoulder flexion [175.2±10.2°]/internal rotation [56.7±10.3°], ankle dorsiflexion [9.8±4.6°], hip extension [18.5±9.4°]) accounting for 95.2% of the FMS variability when the independent variables consisted of ROM and strength (excluding balance) measures. When all measures were included independently female FMS scores [15.1±1.6] had 2 predictive measures (shoulder flexion [175.2±10.2°], hip flexion [87.8±33.4°) that accounted for 93.3% of the variability, lower FMS scores had 2 predictive measures (Sahrmann's scale [2.35±0.7 levels], eyes open unilateral stance test [0.7±0.4°/sec) that accounted for 85.3% of variability, male FMS scores [14.8±1.3] showed 2 predictive measures (knee extension [2.3±2.9°], Sahrmann's scale [2.35±0.7 levels]) that contributed 79.1% variance to FMS final scores, and including all FMS scores regardless of score or gender there were 2 variables (shoulder abduction [182.1+9.8°], SOT composite [77.6±5.5]) that contributed 54.4% variance. No significant predictors were shown for higher (≥16) FMS scores.

Dependent Variables	Mean		S.D.
FMS Final	15.0	±	1.4
FMS Male Final	14.8	±	1.3
FMS Female Final	15.1	±	1.6
Low FMS Scores (≤ 15)	14.2	±	1.0

Table 1: Dependent variables mean and standards deviation

Dependent Variable	Pearson Product-Moment Correlation (r)									
	SldFlx	SldIR	AnkDF	HipExt	HipFlx	SahrScal	UniEO	KneExt	SldAbd	SOTComp
FMS Final	0.43	0.19	0.42	0.22	0.29	0.35	-0.03	0.48	0.50	0.53
FMS Male Final	0.09	0.18	0.44	0.28	0.20	0.58	-0.46	0.58	0.62	0.40
FMS Female Final	0.81	0.12	0.40	0.19	0.45	0.37	0.01	0.19	0.80	0.78
Low FMS Scores (≥ 15)	0.61	0.79	0.35	-0.33	0.34	0.79	0.30	-0.11	0.44	0.62
Low FMS Scores (≥ 15 - ROM/STR)	0.61	0.79	0.35	-0.33	0.34	-	-	-0.11	0.44	-

Table 2: Correlation matrix with highlighted predictive measures (r)

Condition	Predicting Values	Percent of Variance (r^2)
Low FMS Scores (≤ 15) - ROM/Strength	Shoulder Flexion, Shoulder Internal Rotation, Ankle Dorsiflexion, Hip Extension	95.2%
Female FMS Scores - All Measures	Shoulder Flexion, Hip Flexion	93.3%
Low FMS Scores (≤ 15) - All Measures	Sahrmann's Scale, Unilateral Stance Test (Eyes Open)	85.3%
Male FMS Scores - All Measures	Knee Extension, Sahrmann's Scale	79.1%
All FMS Scores - All Measures	Shoulder Abduction, SOT Composite	54.4%

Table 3: All six conditions associated with predictive measures and respected percentages of contribution to variance (r^2) in FMS.

Conclusions

When there is no distinction between high and low scores or gender, and the independent variables include ROM and strength it seems to be an issue of lacking ROM. Gastroc, hip flexor, latissimus dorsi, and posterior cuff tightness are potential contributors to the decrease in FMS scores. When the distinction remains the same as the previous and the independent variables include all measures, it is most likely pectoralis major tightness, latissimus dorsi tightness, and sensory organization deficits that would create the lower FMS scores. If there is a distinction between gender and all measures are included in analyses, females that exhibited hamstring and latissimus dorsi tightness showed lower final scores, but in males with lower scores the subjects exhibited hamstring and gastroc soleus tightness as well as weak abdominals. When dependent variables were separated by high and low FMS scores, those that exhibited weaker abdominals and showed balance issues performed worse on the FMS. There were no predictors found for high FMS scores.

In this study, the results showed that poor performance on an FMS can be predicted using physical measurements, these measurements seem to be heavily ROM based, followed by core stability, and sensory organization. These results lead us to recommend further research in an attempt to find significant predictors of high performance levels on an FMS, which would offer specific measures to focus training programs on to increase functionality and decrease injury risk. We suggest adding a more functional balance test and exploring ROM further as predictive measures of the FMS.