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Relationship Between Stabilization, Balance, Athletic Performance and Functional Movement

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Performance and Functional Movement

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ABSTRACT

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The purpose of this study was to determine the relationship between the functional movement screen (FMS) and a battery of stabilization, balance, and athletic performance assessments, including time to stabilization (TTS), Davies test (DT), Y-Balance test (YBT), and maximum vertical jump (VJ). Sixty-one healthy individuals (32 males, 29 females; age: 22.4 ± 2.7 yr; height: 174.4 ± 10.4 cm, body mass: 74.0 ± 18.8 kg), successfully performed the FMS and the accompanying comparison tests. Correlations were generated between the FMS and TTS, DT, YBT, and VJ (including both unilateral and bilateral assessments) using the R Project for Statistical Computing, with statistical significance set at $p < .001$ to minimize alpha inflation. Weak correlations were generated between participants' total FMS score (summed from the 7 FMS assessments) and the TTS-left side ($r = -.43$; $p < 0.001$), TTS-right side ($r = -.35$; $p<0.006$), DT ($r = .54$; $p < 0.0001$), and VJ ($r = .33$; $p = 0.101$). Moderately strong correlations were generated between total FMS scores and the YBT-left side ($r = .69$; $p < 0.0001$) and YBT-right side ($r = .70$; $p < 0.0001$). Similar weak significant correlations were generated when comparing the scores of each individual FMS screen with the TTS, DT, YBT, and VJ. Of these, the highest correlations were between the in-line lunge-left side and the YBT-left side ($r = .72$; $p \leq 0. 001$); the in-line lunge-left side and YBT-right side ($r = .75$; $p \leq 0.001$); the trunk stability push-up and VJ ($r = .60$; $p < 0.0001$); and the active straight leg raise-left side and TTS-left side ($r = -.46$; $p < 0.0001$). In summary, mostly weak correlations were found between the FMS (involving total or individual scores) and the comparison assessments employed in this study. More rigorous investigations are now warranted to determine the causality of these relationships and how the FMS might be applied to activity of daily living, athletic performance, and injury prevention.

Keywords: musculoskeletal fitness, exercise technique, power, agility

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Table of Contents

List of Tables

Introduction

Recently, strength and conditioning practitioners have speculated on the value of functional movement assessments and accompanying training strategies as a means of improving sport-specific performance (4, 5, 23, 24). Mills et al. (19) defined functional movement as the ability to exhibit proper levels of musculoskeletal stability and mobility throughout the body while completing fundamental patterns with accuracy and efficiency. Thus, as an underlying component of physical fitness, functional fitness is the ability to sit, stand, or move correctly and efficiently in any activity of daily living, recreational activity, or athletic endeavor. For years, strength and conditioning practitioners have taught athletes to perform exercises using proper technique to maximize potential exercise adaptations and to lower the possible risk of musculoskeletal injury (1). However, the recent attention on functional movement patterns appears to take the emphasis of using correct exercise form and technique to a heightened level of understanding and application.

Physical therapists commonly employ a number of tests and measures to assess the overall quality of functional movement patterns (22). In an attempt to provide a standardized test protocol to assess functional movement, Cook et al. (4-6) proposed the functional movement screen (FMS) consisting of seven simple assessments (unloaded deep squat, hurdle step, in-line lunge, shoulder mobility, active straight leg raise, push-up, and rotary stability). Each assessment involves a submaximal effort (over 1 to 3 repetitions) involving unloaded, body weight exercise, while a test administrator judges the movement quality based on a four-point scale. Cook et al. suggests that high FMS scores are indicative of proper musculoskeletal stability and mobility, which should translate into improved athletic performance and lowered athletic injury rates. In contrast, Cook et al. suggests that low FMS scores would have a detrimental influence on athletic performance and lead to higher incidence of injury during athletic events.

Research efforts to explore the veracity of Cook's hypotheses are in the early stages. Minick et al. (20) found that the intertester reliability among testing administrators is acceptable for the 7 FMS assessments, with interreliability scores ranging from 0.74 to 1.00. Two recent correlational studies completed by Okada et al. (23) and Parchmann et al. (24) found consistently weak correlations between FMS scores and various measures of athletic-related performance (e.g., vertical jump, 10- and 20-m sprint times, golf club swing speed, single leg squat, backwards overhead medicine ball throw, etc.) and core stability (McGill's trunk muscle endurance tests). In terms of injury prevention, Keisel et al. (15) reported that a group of professional football players who exhibited lower preseason FMS scores had an increased risk of injury across the football season. Chorba et al. (3) found a similar trend in female basketball players.

The purpose of the present study is to provide additional correlational data involving the FMS and a battery of stabilization, balance, and athletic performance assessments, including time to stabilization (39) Davies test (10), Y-Balance test (25), and maximum vertical jump (18). Our objective is to add to the work of Okada et al.(23) and Parchmann et al.(24) so that strength and conditioning practitioners can better understand the possible relationship between the FMS and athletic performance.

Methods

Experimental Approach to the Problem

The present study sought to further explore the relationship between functional movement and various stabilization, balance, and performance measures. Aside from the VJ

(24), novel tests were selected that previously have not been compared with the FMS. A heterogeneous sample was recruited, including participants with FMS scores ranging from low to high. Participants who displayed any pain on a given test were dropped from the study. Correlations were computed to determine the relationship between FMS scores (both individual and total) and the various comparison assessments. The FMS includes 12 individual functional movements, each scored according to a participant's current movement pattern. Corresponding comparison tests included measures of lower extremity stability (time to stabilization or TTS), upper extremity stability and agility (Davies test or DT), single-leg balance (lower extremity Y-balance test or YBT) and explosive power (vertical jump or VJ).

Participants

Sixty-one healthy individuals (32 males, 29 females) were recruited for this study. Each participant reported having no type of musculoskeletal injury (spinal, lower extremity, upper extremity, etc.) or surgery within the previous six months. Each participant was required to complete an informed consent document and all research procedures of the study were approved by the University's Institutional Review Board.

Procedures

Participants completed a single test session, lasting approximately one hour, which involved preliminary screening activities (informed consent, health history questionnaire, and anthropometric measurements) and data collection. Body mass and height were measured using a balance beam scale and stadiometer, respectively (with participants wearing lightweight clothing and no shoes). Functional movement patterns were evaluated using the FMS, developed by Cook (4, 5), which consists of the following movement assessments: deep squat (DS), in-line lunge (ILL), hurdle step (HS), shoulder mobility (SM), trunk stability push-up test (TSPU), active straight leg raise (ASLR), and rotary stability (RS). The FMS scoring system, ranging from 0 to 3, is described in detail elsewhere (4, 5, 15, 20, 23). Participants were screened using the FMS in the recommended sequence: DS, ILL, HS, SM, TSPU, ASLR, and RS (6). The higher-intensity comparison assessments (VJ, TTS, DT, and YBT) were performed next in a randomized order to minimize any order effect.

Functional Movement Screen

Participants performed the FMS using the recommended test kit (6). The FMS includes seven tests, two performed bilaterally (DS and TSPU) and five performed unilaterally (involving the right and left side: ILLl, ILLr, HSl, HSr, SMl, SMr, ASLRl, ASLRr, RSl, and RSr) for a total of 12 individual assessments. Previous research indicates that the FMS protocol provides acceptable intra-rater reliability and inter-rater reliability (20, 33, 35). Following a brief explanation and demonstration of the FMS, participants performed up to three trials of each assessment, with a brief rest (5 to 10 sec) between each trial. A four point scale (from 0 to 3; 0 = painful movement, 1 = major compensation, 2 = minor compensation, 3 = no compensation) was employed to score each assessment of the FMS as outlined by Cook (2-4, 13, 16, 18). Participants experiencing pain on any assessment were dropped from the study. For the two bilateral assessments (DS and TSPU), the highest score of the three trials was recorded. For the unilateral assessments, the lowest score (on the right and left side) across the three trials was recorded (for example, a participant who scored a three on the right side and a score of two on the left side would receive a final score of two). The total FMS score is equal to the sum of the seven individual test scores (with a maximum possible FMS score of 21).

Vertical Jump

The maximum vertical jump (VJ) test was employed to assess explosive power (18). The VJ is considered an important component of athletic performance and is correlated with one's ability to carry out daily tasks and activities (2, 17, 31). Vertical jump height was measured using a standard countermovement jump-and-reach technique (2, 24) and an adjustable measuring device (37) that is designed to quantify each participant's maximum jump height. To perform the VJ, each participant started with both feet flat on the floor, shoulder width apart. Participants then performed the countermovement jump-and-reach assessment by jumping as high as possible and tapping the measurement arms of the test apparatus with their fingertips at a maximum jump height. The VJ was repeated over three trials (with a 10 to 15 sec rest between each trial), and the single best jump recorded in inches.

Time to Stabilization

The time to stabilization (TTS) test was employed to assess participants' dynamic stability and balance (36-38). To perform this test, participants started with both feet on the floor (without shoes), shoulder width apart, and 70 cm away from the center of a force plate (28, 32, 37, 38). Participants were then instructed to jump from both feet to a height of one-half their maximal VJ (by touching the arm of the test apparatus with their fingertips previously set at that height), land with one foot on top of the force plate, stabilize as quickly as possible, and maintain this final postural position (9). The VICON Nexus system (VICON; Oxford, UK) was employed to measure the time in seconds it took for each participant to stabilize. The VICON system was set at 1000 Hz with 100 frames per second and programmed to record time in hundredths of a second and convert participants' body mass and ground reaction forces into Newtons. Once a given participant had landed on the force plate and was visibly stable for at least 1 sec, the test administrator would turn off the VICON system timer; then, at a later time, the test administrator analyzed the vertical ground reaction force data to determine when the participant successfully stabilized the body's vertical component to within 5% of body mass. The elapsed time to reach this point of stabilization represented the participant's TTS score for that trial (9, 37). Each participant completed the TTS beginning with the left leg as the stance leg, followed by the right leg, as done in previous research (28, 32). Three trials were performed on each side of the body (with a 20 to 30 sec rest between each trial), and the single best (lowest) score was recorded in seconds.

Davies Test

The Davies test (DT) is generally employed to assess the functional ability of the shoulder, which includes scapular stability and scapular proprioception (16). Research has shown the DT to be a valid and reliable assessment in predicting one's ability to return to a given sport following an upper extremity injury (10, 21). In this study, the DT was used to assess upper extremity stability and agility. To perform the DT, males assumed a standard push-up position (prone position, both hands and toes on the floor, elbows fully extended, abdominals firm, and spine curvature neutral) and females a modified push-up position (prone position, both hands and knees on the floor, elbows fully extended, abdominals firm, spine curvature neutral) (8, 30). Participants completed the DT protocol, based on previous research (10, 16, 30), by positioning their hands 36 inches apart in the gender-specific push-up position (standard or modified) and then were instructed to touch the backs of their palms (left fingertips tap the back of the right hand, then right fingertips tap the back of the left hand) as quickly as possible for 15 seconds (10, 16). The total number of touches completed over 15 sec counted as the DT score. The assessment was repeated over three trials (with a 45-sec rest interval between each trial), and the average of the three trials recorded for data analysis.

Y-Balance Test

Single-leg balance was assessed using the lower extremity Y-Balance test (YBT) protocol (with the recommended test kit), which is a modified version of the star balance excursion test (7, 27). The YBT test is performed by having the participant stabilize on a single leg (wearing no shoes) while moving a small plastic box (reach indicator) with the toes of the opposite foot across the floor as far as possible (along the anterior, posterolateral, and posteromedial direction of movement). The distance the reaching leg is able to move the reach indicator box along an attached yardstick quantifies the range-of-motion for that side of the body. To prepare for the test, participant's leg length were measured from the anterior superior iliac spine to the distal portion of the medial malleolus and recorded in centimeters (12, 25, 26). To minimize learning bias, six practice trials were performed in each of the three directions and on both sides of the body, with a 5 to 10 sec rest between each trial (14). Following a 5-min rest period, the YBT assessment was performed. A given test trial was acceptable when the participant: a) kept the stance foot stable without lifting or moving the foot; b) did not allow the reaching leg to touch the floor to assist with balance, and c) kept the reaching leg in contact with the reach indicator box while moving it across the floor (12, 25, 26). Repeat trials were allowed until participants were able to achieve an acceptable test trial. To compute the adjusted composite YBT score, the individual scores (in centimeters) of each movement direction were summed, then divided by 3 times the leg length, and then multiplied by 100 to give a percentage of reach distance verses the leg length (12, 13, 25, 26). This percentage was then recorded for data analysis.

Statistical Analysis

The R Project for Statistical Computing (34) was employed to compute correlation coefficients to ascertain the relationship between FMS scores (both individual and total) and the various comparison assessments. To account for repeated statistical analyses and minimize alpha-inflation, statistical significance was set at $p < .001$.

Results

Sixty-one healthy individuals (age: 22.4 ± 2.7 yr; height: 174.4 ± 10.4 cm, body mass: 74.0 ± 18.8 kg) successfully completed the requirements of this study. Table 1 presents the mean (± SD) data for each functional movement screen and each stability, balance, and performance assessment. The mean total FMS score equaled 15.6 ± 3.0, with 20 participants scoring below 14; 24 participants scoring between 14 and 17; and 16 participants scoring 18 or higher. Weak correlations (Table 2) were generated between participants' total FMS score and the TTS-left side ($r = -.43$; $p<0.001$), TTS-right side ($r = -.35$; $p<0.006$), DT ($r = .54$; $p<0.0001$), and VJ ($r = .33$; $p = 0.101$). Moderately strong correlations were calculated between total FMS scores and the YBT-left side ($r = .69$; $p<0.0001$) and YBT-right side ($r = .70$; $p<0.0001$). Similar weak correlations were found when evaluating the scores of each individual FMS screen with the TTS, DT, YBT, and VJ. Of these, the highest correlations were between the in-line lunge-left side and the YBT-left side ($r = .72$; $p \leq 0.001$); the in-line lunge-left side and YBT-right side ($r = .75$; $p \leq 0.001$); the trunk stability push-up and VJ ($r = .60$; $p < 0.0001$); and the active straight leg raise-left side and TTS-left side ($r = -.46$; $p < 0.0001$). In summary, mostly weak correlations were found between the FMS (involving total or individual scores) and the comparison assessments employed in this study (see Table 2). Correlations involving gender-specific samples were similar to the total sample correlations and therefore are not reported.

Discussion

This study confirms previous research (23, 24) and demonstrates that functional movement scores are weakly correlated with the dynamic stabilization (TTS, DT) and athletic performance (VJ) measures we evaluated. A possible rationale for these weak correlations could be due to the following factors. First, the primary purpose of the FMS is to identify common movement dysfunctions or movement compensations using simple functional movements. The FMS scoring system reflects this purpose in that scores are placed on a continuum (0 = painful movement, 1 = major compensation, 2 = minor compensation, 3 = no compensation). Performance tests, on the other hand, are based on a quantitative performance score with little or no consideration of the quality of movement. Second, while the FMS appears to be effective in detecting various movement compensations, these same movement compensations may have little influence on the score achieved during a performance test. This may occur because a given movement compensation does not directly influence the performance test or the participant has developed alternative ways of achieving proficiency on the performance test (through muscular substitution, synergistic dominance, motor program adaptation, and skill development). Third, the inherent physical requirements of the FMS and performance measures tend to differ markedly. The FMS assessments, for example, are performed at a slow, steady speed, while many performance measures require fast, explosive movements. Thus, performance measures often depend on high levels of muscular strength, power, or skill while the FMS focuses on basic stability, mobility, and movement quality.

Unsurprisingly, the single-leg balance test we evaluated exhibited the highest correlation with the total FMS score (YBT-left side: $r = .69$; $p<.0001$; YBT-right side: $r = .70$; $p<.0001$). This assessment, although slightly more complicated to administer than the FMS, is very similar to the overall purpose of the FMS. For example, the YBT is performed at a similar speed as the FMS and appears to rely on similar functional movement patterns (though the YBT is not scored based on visible movement compensations). Of the seven FMS assessments, the in-line lunge (ILL) that requires unilateral balance on a single leg is probably the most comparable to the YBT. The correlation between the ILL and YBT yielded the highest correlation of the present study ($r = .75$, $p<.0001$); but correlations were not consistent when comparing left-leg versus right-leg scores across the ILL and YBT (with r-values ranging from .60 to .75; Table 2), which may be due to leg dominance differences among the participants.

The TTS, a measure of lower-body dynamic stability and balance, reflected weak correlations with the total FMS score (TTS-left side $r = -.43$ $p<.001$, TTS-right side $r = -.35$ $p = .006$) in the present study. Likewise, DT, an upper-body measure of dynamic stability also exhibited a weak correlation ($r = .54$; $p<0.0001$). Previous research suggests that the TTS and DT are valid and reliable (10, 28); the TTS has also been shown to be a predictive measure of lower extremity injury (28, 29, 36, 38). The DT is a simple upper-body assessment, while the TTS provides a quantifiable force-plate measure of lower-body dynamic stability. Consequently, we hypothesized that the TTS would demonstrate a high level of accuracy and correlate strongly with the FMS, but this was not the case. Again, this may be due to differences in the scoring system, recruitment of a different combination of skeletal muscles depending on the demands of the activity, and differences in motor control and skill requirements of the various assessments. It is interesting to note that Wilstrom et al. found that participant scores on the TTS test were not impaired when the muscles surrounding the ankle were weakened and fatigued, since additional muscle activation of the knee and hip extensors compensated to make up for the deficit (37). Thus, further investigation is warranted to determine the role of muscle activation and motor control patterns during the FMS and various dynamic stability assessments using electromyography (EMG) and three-dimensional (3D) movement analysis.

The vertical jump (VJ), an inherent part of certain sports such as basketball and volleyball, was included in the present study as a measure of athletic performance. Similar to the results of Parchmann and McBride ($r = .249$, $p > .05$), we found a weak, insignificant correlation between the total FMS score and VJ ($r = .33$, $p = .101$, Table 2). Parchmann and McBride also compared the FMS to other performance tests (agility T-test, 10- and 20-m sprint times, golf club swing speed), as did Okada et al. (T-run, single leg squat, and backwards overhead medicine ball throw) and both studies reported weak correlations across each comparison. Even the core stability assessments (McGill's trunk muscle endurance tests) conducted by Okada et al. were weakly correlated to the FMS. These findings suggest that the FMS may not relate to any aspect of athletic performance, but this all-encompassing conclusion is premature without additional research (23, 24). For example, the FMS may correlate well with other aspects of athletic performance such as (a) running economy and endurance exercise (which may be more influenced by movement compensations); (b) the ability to perform movement competency sports such as dance or free style skiing; and (c) the ability to accurately hit a target during a tennis serve, football pass, or golf shot.

Most studies evaluating the FMS and athletic performance have been correlational in nature. Although valuable in describing a relationship between two or more variables, correlational studies are limited in that they are not able to establish causation due to possible confounding variables (1). In essence, all that may be concluded from a correlational study is the level or strength of relationship between two or more variables. To ensure that a given correlation coefficient provides a more generalizable and meaningful value, it is essential that data be collected across a heterogeneous sample. To address this in the present study, we stratified the selection process so that about the same number of participants exhibited low (n = 20), moderate (n = 24), and high (n = 16) total FMS scores. Likewise, future research should utilize heterogeneous samples when evaluating the FMS.

Based on the law of specificity, the most effective way to assess athletic performance competency is to have the athlete perform the exact sport, skill, or movement, rather than a related activity such as the FMS, core stability, 1-RM, or medicine ball throw. Similar activities and assessments may relate to athletic performance, but the primary objective is to determine how each activity or assessment directly or indirectly improves athletic performance. As noted earlier, simple correlational studies are unable to address these more meaningful questions. To better understand how the FMS may or may not influence athletic performance, additional research is necessary to document the exact role that efficient movement patterns (correct technique) and inefficient movement compensations (poor technique) play in athletic performance. As part of this research it may be beneficial to (a) identify specific movement compensations (Trendelenburg sign, poor shoulder/scapular mechanics, etc.) during athletic performance (using EMG, 3D motion analysis, etc.) and ascertain whether or not the FMS can directly or indirectly identify these limitations; (b) determine the exact influence of movement compensations during athletic performance and the potential advantages and disadvantages of using efficient movement patterns as opposed to inefficient movement patterns; (c) the usefulness of the FMS and related functional/corrective exercise programs as a primary or secondary component of an athlete's training routine; and (d) determine if the FMS scores and movement compensations are related to performance plateaus and whether or not eliminating these movement compensations allows an athlete to reach previously unattainable levels of performance.

To date, there appears to be only one treatment-based study involving the FMS and athletic performance. This study, conducted by Goss et al. (11), recruited 90 participants to undergo a functional/corrective exercise and strength training program over six weeks. Following the treatment, the average participant experienced an increase in total FMS score (from 15.14 to 17.62), as well as increases in VJ (1.5 cm), T-test (0.5 sec), single leg hop (13 cm), hop for distance (10%), and kip-ups 32% (with all improvements significant at $p<.05$) (11). However, it is unknown whether these improvements in FMS and performance test scores were due to the functional/corrective exercise treatment or the strength training treatment. Future research is warranted to include additional treatment-based research designs in order to determine more specific cause and effect relationships involving the FMS and athletic performance.

Practical Approach

More research is needed to understand the practical application of the FMS. To date, several correlational studies indicate that the FMS is weakly related to a variety of performance-based assessments, involving muscular strength, power, core stability, and dynamic stability; however more rigorous studies are needed to fully document (a) the correlation of the FMS across all types of athletic performance; (b) the influence of movement compensations during athletic performance and how well the FMS can directly or indirectly identify any possible performance-based compensations; (c) the usefulness of the FMS and related functional / corrective exercise programs as part of an athlete's training routine; and (d) whether or not improving functional movement patterns allows athletes to reach previously unattainable levels of performance.

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Table 1. Means and standard deviations for functional movement screen (FMS) scores, and corresponding performance, stability, and balance test scores (n = 61).

	Males		Females		Total	
	Mean	SD	Mean	SD	Mean	SD
DS	1.78	.83	1.66	.77	1.72	.80
ILLl	2.53	.67	2.45	.78	2.49	.72
ILLr	2.44	.62	2.59	.68	2.51	.65
HSl	2.31	.59	2.07	.70	2.20	.65
HSr	2.53	.51	2.24	.58	2.39	.56
SMl	2.25	.67	2.69	.54	2.46	.65
SMr	2.47	.57	2.83	.47	2.64	.55
TSPU	2.81	.40	2.14	.95	2.49	.79
ASLRl	2.22	.75	2.66	.61	2.43	.72
ASLRr	2.16	.72	2.69	.60	2.41	.72
RSl	2.13	.34	1.93	.26	2.03	.31
RSr	2.03	.31	2.03	.33	2.03	.31
Total	15.63	2.62	15.48	3.46	15.56	3.03
TTSl	2.08	1.64	2.12	1.64	2.10	1.63
TTSr	1.89	1.00	1.81	1.37	1.84	1.18
VJ	23.68	4.51	16.44	265	20.24	5.20
YBTl	94.94	12.97	88.77	12.19	92.01	12.88
YBTr	93.38	13.59	87.77	11.40	90.71	12.81
DT	22.25	4.32	20.81	4.48	21.57	4.42

DS = deep squat; ILLl = in-line lunge-left side; ILLr = in-line lunge-right side; HSl = hurdle step-left side; HSr = hurdle step-right side; SMl = shoulder mobility-left side; SMr = shoulder mobility-right side; TSPU = trunk stability push-up; ASLRl = active straight leg raise-left side; ASLRr = active straight leg raise-right side; RSl = rotary stability-left side; RSr = rotary stability-right side; Total = summed functional movement screen (FMS) score; TTSl = time to stabilization-left side (in seconds); TTSr = time to stabilization-right side (in seconds); VJ = vertical jump (in inches); DT = Davies Test (total repetitions averaged over three 15-second trials); YBTl = Y-balance test-left side (as a percentage); YBTr = Y-balance test-right side (as a Table 2. Correlations between functional movement screen (FMS), performance tests, and balance test (n = 61).

Table 2. Correlations between functional movement screen (FMS), performance tests, and balance test (n = 61).

	TTSl		TTSr		VJ		DT		YBTl		YBTr	
	r	*P*	*r*	*p*	*r*	*p*	*r*	*p*	*r*	*p*	*r*	*p*
DS	-.18	.174	-.02	.879	.17	.202	.38	.003†	.35	.005†	.36	.005†
ILL1	-.29	.023†	-.24	.059	.39	.002†	.51	.000‡	.72	.000‡	.75	.000‡
ILLr	-.39	.002†	-.28	.028†	.23	.076	.47	.000‡	.60	.000‡	.63	.000‡
HSl	-.26	.046	-.27	.036†	.33	.010†	.24	.058	.47	.000‡	.48	.000‡
HSr	-.24	.059	-.30	.021†	.41	.001‡	.44	.000‡	.47	.000‡	.49	.000‡
SMl	-.17	.195	-.04	.770	-.16	.210	.28	.030†	.23	.072	.26	.044†
SMr	-.12	.359	-.08	.529	-.18	.177	.25	.057	.28	.028†	.30	.021†
TSPU	-.11	.267	-.08	.553	.60	.000‡	.48	.000‡	.63	.000‡	.58	.000‡
ASLRl	-.46	.000‡	-.34	.008†	-.03	.793	.24	.064	.19	.154	.17	.181
ASLRr	-.44	.000‡	-.39	.002†	-.11	.382	.24	.069	.25	.054	.24	.063
RSl	-.22	.091	-.26	.044	.33	.009†	.23	.079	.19	.150	.20	.118
RSr	-.23	.077	-.04	.740	.05	.724	.08	.530	.15	.253	.15	.261
Total	-.43	.001‡	-.35	.006†	.33	.101	.54	.000‡	.69	.000‡	.70	.000‡

DS = deep squat; ILLl = in-line lunge-left side; ILLr = in-line lunge-right side; HSl = hurdle step-left side; HSr = hurdle step-right side; SMl = shoulder mobility-left side; SMr = shoulder mobility-right side; TSPU = trunk stability push-up; ASLRl = active straight leg raise-left side; ASLRr = active straight leg raise-right side; RSl = rotary stability-left side; RSr = rotary stability-right side; Total = summed functional movement screen (FMS) score; TTSl = time to stabilization-left side (in seconds); TTSr = time to stabilization-right side (in seconds); VJ = vertical jump (in inches); DT = Davies Test (total repetitions averaged over three 15-second trials); YBTl = Y-balance test-left side; YBTr = Y-balance test-right side.

†$p \leq .05$

‡$p \leq .00$