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Correlation between Functional Movement Screen Scores and Selected Collegiate Students' Fitness Tests

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Abstract

The National Students' Physical Fitness Standard is a standard for evaluating individual students' physical fitness. However, the standard's corresponding tests lack relevant methods for evaluating human movement quality. This study aimed to explore the correlation between Functional Movement Screen (FMS) scores and fitness test results of selected collegiate students to provide a theoretical basis for including the FMS into a student's physical fitness test battery. Thirty-one undergraduate swimming majors from a sport university volunteered to participate in four tests: FMS, sit and reach, standing long jump, and 50-m dash. The test protocol strictly followed the corresponding requirements of the FMS and student physical fitness tests. The FMS scores as well as sit and reach test, standing long jump, and 50-m dash results were 15.9 ± 2.2 cm, 17.3 ± 7.0 cm, 232.6 ± 29.4 cm, and 7.88 ± 1.06 s, respectively. The total FMS score was only significantly correlated with the 50-m dash result ($p < .05$), but there was no significant correlation ($r < .4$) between the total FMS score and the three fitness test results. The correlation between individual FMS scores (except the trunk stability push-up [TSPU]) and the selected fitness test results was not significant ($p > .05$). TSPU scores were significantly correlated with the standing long jump and 50-m dash results ($p < .01$, $r > .7$) but not with the sit and reach test results ($p > .05$). The deep squat, hurdle step, in-line lunge, shoulder mobility, and active straight leg raise scores in the FMS were not significantly correlated with the selected fitness test results ($p > .05$). These findings showed that as a moderately reliable measure of human movement quality, the FMS could compensate for the current collegiate students' fitness tests for evaluating movement quality. To further explore the correlation between FMS scores and physical fitness test results, we recommend that future studies should select a larger and more diverse sample and that complete physical examinations be conducted on all subjects. This will provide a more scientific theoretical basis for including the FMS into a student's physical fitness test.

Keywords: functional movement screen, fitness test, collegiate students, FMS, China

Introduction

The "National Student Physical Fitness Standard" (last revised in in 2014; henceforth referred to as the "standard") is an evaluation standard for measuring students' physical fitness and exercise results. It is not only the basic national physical fitness requirement for students of different ages but also the standard by which individual students' physical fitness are evaluated (Ministry of Education, 2014a). After many revisions, this standard is currently applied to students in full-time ordinary primary schools, middle schools, ordinary high schools, secondary vocational schools, and general colleges and universities. The indicators include the three categories, including morphology, function, and quality (Zhang, 2014; Zhen, Zhang, & Xing, 2006). For the collegiate student population, physical fitness test items include body mass index, lung capacity, a 50-m dash, a sit and reach test, a baseline jump, pull-ups (men)/1-min sit-ups (women), and a 1000-m dash (men)/800-m dash (women) (Ministry of Education, 2014a). However, these test items are objective measures, i.e., they are quantified by measuring data such as time, distance, and number without considering the quality of movements performed by the tested person (McCunn, Aus der Fünten, Fullagar, McKeown, & Meyer, 2016).

The Functional Movement Screen (FMS), which was developed by the American physicist Gray Cook, is a test method used to evaluate people's basic abilities to move (Cook, 2003). It is one of the limited number of methods available for assessing human movement quality that has been rated "good" in terms of reliability (inter- and intra-rater reliability) (McCunn et al., 2016; Y.-M. Li, Zi, & Chen, 2013). Although the FMS is still controversial in terms of its ability to predict athletic performance and sports injuries (Hammes, Aus der Fünten, Bizzini, & Meyer, 2016; Kraus, Schutz, Taylor, & Doyscher, 2014), its simplicity, user-friendliness, low testing costs, non-invasiveness, and relative effectiveness are the reasons why it is currently being widely used in athletes, special groups (including firefighters and soldiers), and the general population (Cuchna, Hoch, & Hoch, 2016; Y.-M. Li, Wang, Chen, & Dai, 2015). In light of the fact that Taiwan's current methods for testing students lack ways to evaluate movement quality and that the FMS can measure basic movement abilities fairly well, in recent years, domestic scholars have been exploring the correlation between FMS scores and students' physical fitness test results in an attempt to introduce the FMS into students' physical fitness tests (Han, 2015; Q. Li, Liu, Hong, & Chen, 2015; Liu, Chen, & Lu, 2015; Zhang & Zhu, 2016). However, these efforts have mostly been limited to research on the correlation between total FMS scores and physical fitness tests and/or limited to tests performed on young people (Liu et al., 2015). The researchers failed to disclose whether the testers had FMS-related qualifications (Q. Li et al., 2015; Liu et al., 2015). However, the research had already determined that FMS totals are independent of the scores from respective individual tests (Kazman, Galecki, Lisman, Deuster, & O'Connor, 2014; Y.-M. Li et al., 2015) and that testers' FMS qualifications and/or experience influence FMS scores (Gulgin & Hoogenboom, 2014; Shultz, Anderson, Matheson, Marcello, & Besier, 2013).

In view of this, the present study used swimming majors from a sports academy as its research subjects to explore the correlation between the FMS and some physical fitness test results to provide a theoretical basis for introducing the FMS to collegiate students' physical fitness test batteries, thus improving the current physical fitness program for them.

Methods

Research Subjects

Thirty-one healthy moderate-trained swimmers from a sport university volunteered to participate (male: n = 20, age = 21 ± 1 years, height = 179 ± 4 cm, weight = 73 ± 7 kg; female: n = 11, age = 20 ± 1 years, height = 169 ± 5 cm, weight = 62 ± 10 kg). The test subjects were familiar with the research purpose and protocol. They did not do any strenuous exercise one day before the test and ate normal meals on the day of the test. All test subjects finished the tests within half a day (13:30–17:00). The testing environment was a 200-m athletic field. Every tester was conducting the FMS for the first time and was therefore unfamiliar with the scoring standards (Frost, Beach, Callaghan, & McGill, 2015).

Test Protocol

All testers participated in the FMS and three standard tests (sit and reach test, standing long jump, and 50-m dash) as shown in Figure 1. Given the influence of the testers' experience on FMS scores (Frost et al., 2015), the FMS for this study was completed by a staff member who

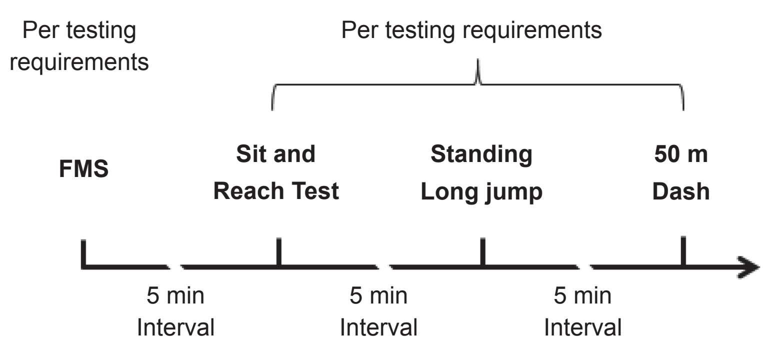

Figure 1. Illustration of the test protocol. FMS refers to the Functional Movement Screen, while standard refers to the National Student Physical Fitness Standard (last revised in 2014).

was specially trained and has extensive testing experience with EXOS Human Performance company in the USA. The FMS includes seven tests: deep squat (DS), hurdle step (HS), in-line lunge (ILL), shoulder mobility (SM), active straight leg raise (ASLR), trunk stability push-up (TSPU), and rotary stability (RS). HS, ILL, SM, ASLR, and RS involve asymmetric movements. The subjects separately test each side of their body. SM, TSPU, and RS are three additional injury-screening tests. Each tested movement was given a score from 0 to 3. A perfect score in all 7 tests is 21 (3 × 7) (Y.-M. Li et al., 2013). The tests were explained and demonstrated to each test subject in accordance with FMS requirements. No test subjects were informed of their scores during the test, and they did not receive any instruction on how to perform the movements (Cook, 2010).

The test subjects completed the FMS, followed by the sit and reach test, standing long jump, and 50-m dash. All tests strictly followed the "standard" protocols (Ministry of Education, 2014b). Student tests included the 50-m dash, sit and reach test, standing long jump, pull-ups (men)/1-min sit-ups (women), 1,000-m dash (men)/800-m dash (women) (Ministry of Education, 2014a). In the present study, three gender-neutral tests (both genders perform the same tests) were selected: sit and reach test, standing long jump, and 50-m dash. The results of these three tests show the test subjects' speed, flexibility, and strength (Zhang, 2014). The test subjects completed the sit and reach test two times (with the better result being used), the standing long jump three times (with the best result being used), and the 50-m dash one time according to the standard requirement.

Statistical Analyses

The individual FMS scores, total FMS score, and three physical fitness test results are presented as *mean* ± standard deviation (*SD*). The individual FMS scores/total FMS score and three physical fitness test results were analyzed using Spearman's rank correlation, and $p = .05$ and $p = .01$ were chosen to indicate significance. No correlation was obtained between the RS and any other test scores in the FMS because all test subjects had the same score: 2.

Results

The individual FMS scores and total score of the test subjects were 1.8 ± 0.8 (DS), 2.3 ± 0.5 (HS), 2.7 ± 0.4 (ILL), 2.2 ± 0.8 (SM), 2.5 ± 0.6 (ASLR), 2.3 ± 0.9 (TSPU), 2.0 ± 0.0 (RS), and 15.9 ± 2.2 (total score). The three physical fitness test results were 17.3 ± 7.0 cm (sit and reach test), 232.6 ± 29.4 cm (standing long jump), and 7.88 ± 1.06 s (50-m dash) (Table 1).

The total FMS score was only significantly correlated with the 50-m dash physical fitness test results ($p < .05$), but the total FMS score was not highly correlated with the three physical fitness test results (correlation coefficient < 0.4). With the exception of the TSPU score, the individual FMS scores were not correlated with the three physical fitness test results ($p > .05$). The TSPU score was highly correlated with the standing long jump and 50-m dash results ($p < .01$, $r > .7$). The TSPU score and sit and reach test result ($p > 0.05$) were not significantly correlated ($p > .05$). There was no significant correlation between the DS, HS, ILL, SM, and ASLR scores and the three physical fitness test results ($p > .05$). There was an obvious correlation between the total FMS score and the individual scores ($p < .05$). There was no significant correlation between the individual FMS scores ($p > .05$, except for SM and ASLR). There was no correlation between the three

Table 1
Results of FMS and Three Fitness Tests

Test	*Mean* ± *SD*
FMS	
DS	1.80 ± 0.80
HS	2.30 ± 0.50
ILL	2.70 ± 0.40
SM	2.20 ± 0.80
ASLR	2.50 ± 0.60
TSPU	2.30 ± 0.90
RS	2.00 ± 0.00
Total Score	15.90 ± 2.20
Physical Fitness Test	
Sit and reach (cm)	17.30 ± 7.00
Standing long jump (cm)	232.60 ± 29.40
50-m dash (s)	7.88 ± 1.06

Note. FMS = Functional Movement Screen; DS = deep squat; HS = hurdle step; ILL = in-line lunge; SM = shoulder mobility; ASLR = active straight leg raise; TSPU = trunk stability push-up; RS = rotary stability.

physical fitness test results ($p > .05$). There was a significant correlation between the standing long jump and 50-m dash results ($p < .01$, $r = -.909$) (Table 2).

Discussion

The findings of the present study showed that FMS scores are not highly correlated with the three physical fitness test results (sit and reach, standing long jump, and 50-m dash; $r < .4$). Individual FMS scores, except for TSPU, are not significantly correlated with the three physical fitness test results ($p > .05$). This shows that the ability of the FMS to evaluate movement quality seems to make up for the lack of such movement quality assessment in a students' physical fitness test in the present study.

The finding that the total FMS score and most individual FMS scores were either not very correlated or not at all correlated with the three physical fitness test results is consistent with findings in the literature (Q. Li et al., 2015; Liu et al., 2015). Liu et al. (2015) conducted FMS tests and physical fitness tests on 190 middle school students. They discovered that there was no significant correlation between their total FMS scores and physical fitness test results (Liu et al., 2015). Q. Li et al. (2015) conducted FMS tests and physical fitness tests on 490 young athletes, ordinary middle school students, and ordinary university students. They discovered that there was no significant correlation between the three groups' total FMS scores and physical fitness test results (Q. Li et al., 2015). However, the limitation of these two studies is that correlation analysis was not conducted between individual FMS scores and individual physical fitness test results. Q. Li et al. and Kazman et al. (2014) conducted FMS tests on high-level athletes and navy reserve corps and found

Table 2

Pearson's Correlation of Results between FMS and Three Fitness Tests

	DS	HS	ILL	SM	ASLR	TSPU	RS	Total	Sit and reach	Standing long jump	50-m dash
DS	1.000										
HS	0.080	1.000									
ILL	0.119	0.242	1.000								
SM	0.283	0.043	0.132	1.000							
ASLR	0.148	-0.064	0.281	0.368**	1.000						
TSPU	0.283	0.017	-0.043	0.009	-0.159	1.000					
RS	—	—	—	—	—	—	—				
Total	0.725*	0.377**	0.384**	0.596*	0.337	0.488*	—	1.000			
Sit and reach	0.172	-0.102	0.330	0.137	0.091	-0.141	—	0.110	1.000		
Standing long jump	0.259	-0.181	-0.194	-0.051	-0.337	0.707*	—	0.219	-0.029	1.000	
50-m dash	-0.291	0.079	0.124	-0.133	0.185	-0.749*	—	-0.397**	0.133	-0.909*	1.000

Note. FMS = Functional Movement Screen; DS = deep squat; HS = hurdle step; ILL = in-line lunge; SM = shoulder mobility; ASLR = active straight leg raise; TSPU = trunk stability push-up; RS = rotary stability; the corresponding value of RS is blank because all RS scores were 2, making it impossible to compile results; total score = total function movement screen score.

$^{*}p < .01$, $^{**}p < .05$.

that individual FMS scores were independent of each another and recommended that more attention should be paid to individual FMS scores when analyzing FMS scores. Therefore, merely analyzing the correlation between total FMS scores and physical fitness tests results is insufficient. In addition, only the TSPU score correlated with the standing long jump and 50-m dash physical fitness test results (correlation coefficient > 0.7). This may prove that the core stability measured by TSPU, the strength showed in long jump, and the speed measured in the 50-m dash is correlated to some extent. Nesser, Huxel, Tincher, and Okada (2008) conducted core stability tests (McGill, 2002) and athletic performance tests on American Division I football players. They discovered that the test subjects' core stability, vertical leap, and 40-m dash results were correlated. The study by Okada, Huxel and Nesser (2011) on the general population also showed that core stability (McGill, 2002) and backward medicine ball toss exercise results are significantly correlated (Okada et al., 2011). However, this study selected three physical fitness tests with objective evaluation criteria, i.e., those evaluated by time and distance without taking into consideration movement quality (McCunn et al., 2016). Physical fitness tests should evaluate movement quality to obtain a clear understanding of the subject's fitness or athletic performance (McCunn et al., 2016). Although no consensus has been reached on movement quality and/or how to measure it, the FMS is currently one of the few widely used methods. It is simple, easy to use, relatively inexpensive, non-invasive, and relatively effective (Li et al., 2013). Therefore, it is suitable for use among university students to conduct timely monitoring and evaluate deficiencies in their movements.

The subjects in the present study had an average total FMS score of 15.9. This is comparable to the following averages found in the literature: general population (around 15) (Perry & Koehle, 2013; Schneiders, Davidsson, Hörman, & Sullivan, 2011), high-level athletes (15.2) (Q. Li et al., 2015), and military medical staff (Teyhen et al., 2014). However, it is higher than other averages: high school athletes (around 13) (Bardenett et al., 2015), adult runners (13.1) (Agresta, Slobodinsky, & Tucker, 2014), and elderly people above 50 years old (< 15) (Perry & Koehle, 2013). However, because individual FMS scores are independent, Y.-M. Li et al. (2015) and Kazman et al. (2014) recommend that more attention should be paid to individual FMS scores, instead of only focusing on the total FMS score. The results of the present study are consistent with the results found in literature: individual FMS scores are not correlated with each other ($p > .05$), with the exception of SM and ASLR. Even though the total FMS score was significantly correlated with the individual FMS scores (with the exception of ASLR), this does not mean that the total FMS score can be used in place of the seven individual scores because the total FMS score conceals problems hidden in the movement test among participants (Kazman et al., 2014; Y.-M. Li et al., 2015). For example, one test taker with a total FMS score of 18 may have individual scores of 2 + 2 + 2 + 3 + 3 + 3 + 3 but may also have scores of 3 + 3 + 3 + 3 + 3 + 3 + 0. A test taker with the latter scores has more serious problems in terms of movement quality.

The present study only selected three physical fitness tests and did not select pull-ups (men)/1-min sit-ups (women) and/or the 1000-m dash (men)/800-m dash (women). One reason for this was because of the relatively small sample size (31 test subjects: 20 males and 11 females), which would make the relative sample size even smaller when divided by gender. The other reason was that the 1000-m and 800-m dashes are exhaustive tests; thus, their results are prone to be influenced by participants. The sit and reach, standing long jump, and 50-m dash tests reflected the test takers' flexibility, strength, and speed (Zhang, 2014). The results showed that flexibility is not correlated with strength and speed but that strength and speed are correlated. Although we did not find reports on the correlation between students' physical fitness test results, the results of the present study show that we can pick one test from among the standing long jump and 50-m dash tests to simplify the protocol. From a metabolic standpoint, both tests measure phosphate-based energy supplies (Li, Ji, & Zi, 2014).

This study has a few limitations. First, there were only 31 test subjects, so the relatively small sample size may affect the FMS scores and physical fitness test results as well as any analysis of their correlation. However, the FMS scores and the correlation between them obtained from the study are similar to those present in the existing literature. Furthermore, the test subjects were undergraduate swimming majors from a sport university and their athletic levels were equal to or higher than the national level of 2. While this group of trained athletes used motions that may be best suited to swimming, the FMS scores found in the present study were close to those prevalent in existing studies. This seems to show that swimming has little influence on research samples. Third, this research only selected three collegiate student physical fitness tests. It did not include other physical fitness tests as well as form and/or ability tests. The relevance of the FMS score to these untested items remains unclear. Therefore, we recommend that future research projects should select a larger and more diverse sample of collegiate students and that test subjects be given complete physical fitness tests. This will allow us to further explore the correlation between the FMS and physical fitness tests to provide a more scientific theoretical basis for including the FMS into a collegiate student's physical fitness test battery.

Conclusions

The total FMS score and most individual FMS scores were either not highly or not at all correlated with the three physical fitness test results for collegiate students; the ability of the FMS to evaluate movement quality seems to make up for the lack of such movement quality assessment in the students' physical fitness test results in the current study. Future studies should include larger and more diverse samples of students and give those students complete physical fitness tests. This will allow us to further explore the correlation between the FMS scores and physical fitness test results to provide scientific evidence for the inclusion of the FMS in a student's physical fitness test battery.

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