Research Paper: The Relationship Between Dynamic Stability and Functional Movement Screening Test

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Citation Zarei M, Rahmani N. The Relationship Between Dynamic Stability and Functional Movement Screening Test. Physical Treatments. 2018; 8(2):107-114. http://dx.doi.org/10.32598/ptj.8.2.107

doi: http://dx.doi.org/10.32598/ptj.8.2.107

Article info:
Received: 10 Jan 2018
Accepted: 23 May 2018
Available Online: 01 Jul 2018

Keywords:
Movement screening, Dynamic balance, Y Balance Test, Functional Movement Screen (FMS)

ABSTRACT

Purpose: Recently, the Functional Movement Screen (FMS) and Y Balance Tests are used to assess the key movement patterns, dynamic stability and to identify individuals at high risk of injury. But, there are few studies to assess the relationship between the FMS test and Y Balance Test. This study aimed to assess the relationship between dynamic stability and the FMS test.

Methods: The subjects of this study were 95 students (Mean±SD age=26.7±3.13 y, Mean±SD height=177.4±6.9 cm, Mean±SD weight=72.02±6.91 kg, and Mean±SD BMI=22.93±0.41 kg/m^2) from a university complex. All subjects were evaluated prior to the onset of training. Y Balance Test was used to evaluate dynamic stability and FMS test for evaluating the movement patterns of the subjects.

Results: The Pearson correlation coefficient was used to assess the relationship between variables. The results showed a significant association between the FMS score and the aggregate Y score (r=0.205, P=0.04). Also, there was a weak correlation between FMS and normalized posteromedial reach (r=0.27, P=0.04). However, the correlation between FMS and normalized anterior reach and posterolateral reach was not statistically significant (P>0.05).

Conclusion: These findings demonstrate partial correspondence between the two tests. However, the relationship is not strong enough to consider them interchangeable. Thus, dynamic postural control is not a large component of the aggregate FMS score.

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Highlights

● Functional Movement Screen and Y Balance Tests can evaluate dynamic stability, mobility, movement patterns and identification of people at risk of injury.

● There is a significant relationship between scores of the Functional Movement Screen and an overall score of Y Balance Tests.

Plain Language Summary

Recently, Functional Movement Screen (FMS) and Y Balance Test (YBT) have been increasingly used to evaluate fundamental movement patterns, dynamic stability, and practically identify individuals at risk of injury. This study aimed to investigate the association between the scores of these two tests. The study participants were 95 students selected by convenience sampling method. YBT was used to measure their dynamic stability and FMS for measuring their fundamental movement patterns. Results indicated a significant relationship between their scores. There was a weak correlation between FMS score and YBT score in posteromedial reach direction but no correlation was found between scores of FMS and YBT in anterior and posterolateral directions. Although the results of this study show a small correlation between the two tests, this relationship is not strong enough for the tests to be used interchangeably. In other words, dynamic stability is not a part of FMS.

1. Introduction

One of the most reliable methods of preventing injuries is to identify the compensatory movement patterns and correct them. For this reason, the use of movement screening tests in assessing the physical deficiencies of athletes and other active individuals has been dramatically increased [1]. Researchers have recommended several methods and tests for movement screening. However, the most popular method is the Functional Movement Screen (FMS) test, which is used as a screening tool for identifying movement weaknesses and incorrect functional patterns [2]. Many studies reported the role of this test in identifying the athletes at risk of injury and predicting injuries in other groups, too [3-8].

Posture stability is another clinically important indicator of the musculoskeletal system health. The significance of balance in sports and injury prevention is also evident [9]. Lack of dynamic stability in active people can expose them to various damages. For this reason, screening of those with a deficiency in dynamic stability, those who are very active (e.g. athletes & soldiers) and prone to musculoskeletal injuries is very important. The Star Excursion Balance Test (SEBT) is among the best methods for assessing dynamic postural-control deficits [10].

The Y Balance Test (YBT) is the modified form of SEBT. The implementation of SEBT requires strength, a sense of depth, balance, and proprioception [11]. Studies indicate that people with low scores in this test are at higher risk of injury. McCunn et al. (2016) reported that athletes who had a weaker balance than others were up to 7 times more likely to be injured [1].

Both YBT and FMS can assess dynamic postural control, stability, motion, and movement patterns, to identify people at risk of injury [2, 12, 13]. Accordingly, some studies have examined the relationship between YBT and FMS scores. For example, Engquist et al. (2015) investigated athlete students and general college students. They found no difference in FMS composite scores among them. However, female athlete students scored higher than female general college students in YBT composite scores [14]. Another study explored 200 National Collegiate Athletic Association athletics.

They reported that athletes with a history of operation or injury had worst FMS scores, where female athletes performed worse in FMS movement patterns for trunk and rotary stability. Moreover, female athletes scored better in the lunge, shoulder mobility, and straight leg raise. However, there was no significant difference in the YBT scores between female athletes with and without histories of injury and surgery [15]. Teyhen et al. (2014) used normalized FMS and YBT data on military members. Their study suggested that FMS scores, power, balance, mobility, and functional movement of younger individuals (<30 y) were better than those of older par-

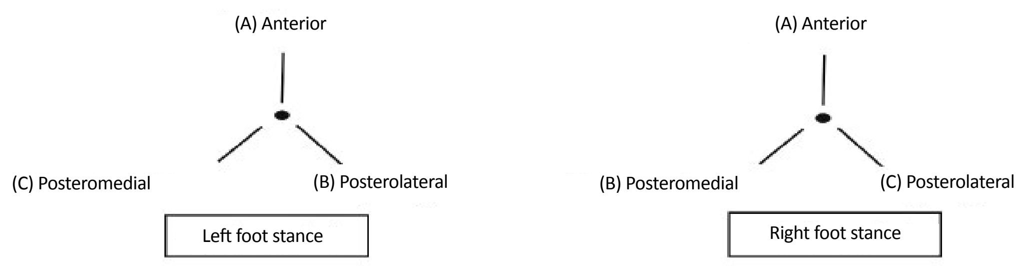

Figure 1. YBT reach directions for both feet

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ticipants. Additionally, men performed better on power, balance, and trunk stability tests [16].

Kelleher et al. (2017) observed weak correlations between composite FMS scores and normalized posterolateral reach, normalized posteromedial reach, and the total YBT score [17]. However, Scudamore et al. (2018) indicated a high association between the total scores of FMS and YBT, and overall stability indices [18]. Both FMS and YBT evaluate the movement patterns and stability of active people. However, the results of studies on the relationship between their scores are contradictory. Therefore, this study examined the correlation between FMS and YBT among students.

2. Materials and Methods

This correlational study was conducted on 95 students aged 20-30 years. The subjects had no histories of cardiovascular diseases, blood diseases, liver diseases, as well as kidney, respiratory, hormonal, and metabolic disorders (blood pressure, diabetes), smoking or use of certain medication. In addition, no subject was prohibited from physical activity and exercise, including climbing and walking. The FMS test consists of 7 fundamental movement patterns, and given the quality of a person's performance, the obtained score in each area ranges from 0 to 3 [2, 12]. The maximum achievable score is 21 [19]. The seven tests include the squat, hurdle step, lunge, shoulder mobility, active straight leg raise, push-up, and rotary stability.

A score of 3 indicates that the movement was completed with no compensation and pain. A score of 2 indicates that the subject could complete the movement with compensation. A score of 1 indicates that the subject failed to complete the movement, and 0 is assigned if the subject experiences pain with any movement [20]. A detailed procedure of the FMS test is provided in our previous study [21]. YBT is a reliable and valid assessment tool for dynamic postural control (α=0.86-0.95) [22, 23]. It has excellent test-retest and Inter-rater reliability calculated with intraclass correlation coefficients as 0.98 and 0.91, respectively [24].

The test was performed with the subject standing at the center of the platform with 3 cloth tape measures attached to the floor; one in the anterior direction and others positioned 135 degrees from the anterior tape. Subjects performed single-leg stance while extended the other leg as far as possible along the reach directions (anterior, posteromedial, and posterolateral), shown in Figure 1. When the reach foot touched the furthest point possible, the subject returned to the bilateral stance position while maintaining the balance.

The examiner measured the distance from the center of the grid to the touch point. Reach distance was then normalized by dividing it by the subject' limb length and then multiplying it by 100 [11, 22]. The subject's limb length was measured using a cloth tape measure from the anterior superior iliac spine to the medial malleolus tip, in lying down position. Before conducting the tests, each subject performed 6 practice trials to minimize the learning effect [25, 26], followed by a rest period. Then, they performed 3 trials in each direction on the stance foot. The mean normalized score of 3 trials was recorded as the subject's YBT score. In order to prevent the effect of testing order on the data, the starting direction was randomly selected using the specified cards.

The trials were repeated if the subject failed to keep hands on the hips, used the reach foot for stance support, or failed to maintain unilateral stance on the platform. Each subject had to perform this test at the beginning and end of the study. Composite reach distance was measured as the sum of 3 reach directions (anterior, posteromedial, and posterolateral), divided by 3 times limb length, then multiplied by 100 [25]. To examine the correlation between the FMS and YBT scores, the Pearson Correlation Coefficient (PCC) was applied in SPSS by considering the significance level of 0.05 ($P<0.05$).

3. Results

In this cohort study, data of 95 students were analyzed. Their demographic characteristics are presented in Table 1. Kolmogorov-Smirnov test results indicated the normal distribution of FMS and YBT scores (P=0.23). As illustrated in Figure 2, there is a significant relationship between FMS scores and overall YBT scores (r=0.205, P=0.04). Chan (2003) found a slight correlation between these two variables [27].

According to PCC results presented in Table 2, there is a significant correlation between the scores of FMS and YBT in posteromedial reach direction (r=0.277, P=0.04). However, no correlation was observed between FMS and YBT scores in anterior (r=0.174, P=0.09), and posterolateral (r=0.093, P=0.12) directions.

4. Discussion

The current study evaluated the correlation between dynamic stability and FMS scores in students aged 20-30 years. The obtained results revealed a significant relationship between FMS scores and overall YBT scores. There was a significant correlation between FMS and YBT scores in posteromedial reach direction. However, no correlation was found between FMS and YBT scores in anterior and posterolateral directions.

In a similar study, Lockie et al. (2015) compared the scores of FMS and SEBT. They reported a direct correlation between the scores of trunk stability push-up and lunge in FMS and SEBT, in posteromedial reach direction [28]. Another study reported a significant correlation between the score of trunk stability push-up in FMS

Table 1. Demographic characteristics of the study participants

Characteristics	Mean±SD
Age, y	26.67±3.13
Height, cm	177.41±6.91
Weight, kg	72.2±9.61

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Table 2. The Pearson correlation coefficients between FMS and YBT scores

Variable	Overall YBT Score	YBT Posteromedial Reach	YBT Anterior Reach	YBT Posterolateral Reach
FMS	0.205*	0.277*	0.174	0.093

* Significant at P<0.05

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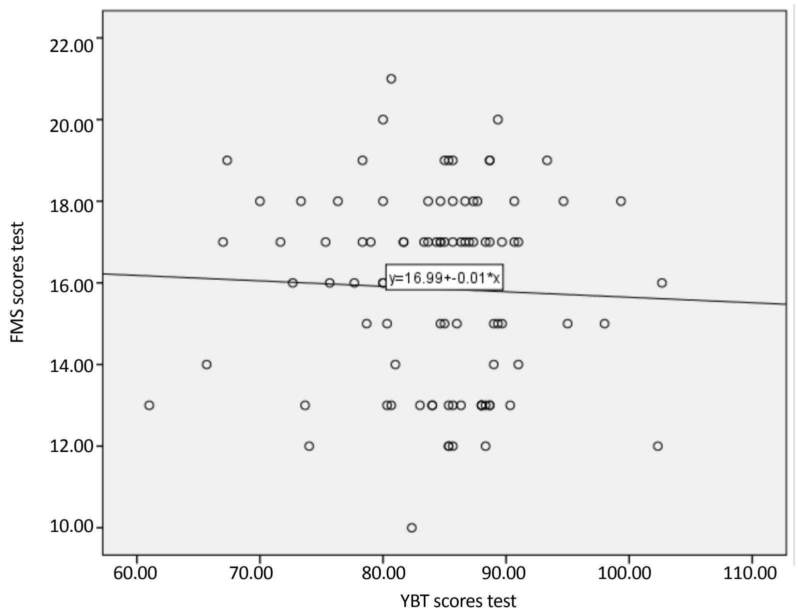

Figure 2. FMS scores vs. overall normalized YBT scores

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and anteromedial reach distance in SEBT [29]. In their study, the subjects performed SEBT with 8 directions, while in our study, YBT was performed in 3 directions. However, prior research suggested that we could not compare reach distance in SEBT with FMS score [29].

Engquist et al. (2015) reported no significant correlation between FMS and YBT scores in male athlete and non-athlete students, while in female subjects, the correlation was significant. They also reported that female athlete students scored higher than female non-athlete students in YBT composite scores; however, no difference was found for men in YBT composite scores [14]. Their results are comparable with ours, although the samples of our study were only active students.

The FMS structure for measuring its scores are expected to explain the poor correlation between the total FMS scores and the YBT reach distance, obtained in the present study. The added scores of FMS movement patterns account for the total FMS score. As a criterion for assessing the overall quality of functional movements, it is suggested that the FMS rating has a one-dimensional structure [30-32]. In contrast, according to the FMS standard, it is a screening tool in which the total score must be calculated and its patterns should not be interpreted individually [2, 12, 13].

In some studies, FMS scores have been assessed in combination [33, 34], while some have separately assessed the scores of specific movement patterns [28, 29]. In this study, a significant correlation was reported between the scores of FMS and overall scores of YBT. However, the lack of a significant correlation between anterior and posterolateral reach directions in YBT indicates a slight correlation between FMS and YBT scores. Thus, dynamic stability is not a determining element of FMS and these tests cannot be used as alternatives. Functional training is an important part of an exercise program. The FMS is often used by fitness professionals to identify weaknesses, imbalances, and compensatory movement patterns that can be corrected by training [35].

Considering the results of this research, it is suggested that other studies be conducted on the effect of dynamic balance exercises on FMS scores. Additionally, by integrating the scores of FMS and YBT, the effectiveness of FMS should be evaluated in predicting the performance and injuries in active people. One of the most important strengths of the present study was the desired sample size (n=95). Most of the previous similar studies had a sample size of fewer than 60 subjects. Another strong point of this study was using one examiner to assess both tests which increased their reliability. The subjects' different levels of physical fitness and their wide age range (20-30 years) are some limitations of the present study that should be considered in generalizing the obtained outcomes.

Ethical Considerations

Compliance with ethical guidelines

All ethical principles were considered in this article. The participants were informed about the purpose of the research and its implementation stages; they were also assured about the confidentiality of their information; Moreover, They were allowed to leave the study whenever they wish, and if desired, the results of the research would be available to them.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Authors contributions

All authors contributed in preparing this article.

Conflict of interest

The authors declared no conflict of interest.

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