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Relationship of functional movement screening with balance and flexibility in adult nonathletes—an observational study

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Abstract

Background The functional movement screening (FMS), Flamingo balance, Y balance, and sit and reach tests are the screening tools for fundamental movement patterns, balance, and flexibility, respectively; the latter three tests are components of quantifying fitness levels. Functional movement screening is used to measure the quality of movement, and it is an injury risk predictor. There are several studies done to find the correlation between functional movement screening and fitness parameters in athletes but has not been studied much in non-athlete population. The aim of this study is to determine the correlation between functional movement screening with static and dynamic balance and flexibility in healthy adult nonathletes, and to find gender differences, if any.

Method A total of 65 healthy nonathletes in the age group 18 to 27 years were included in the study based on the selection criteria. The functional movement screening, Y-balance test, Flamingo balance test, and sit and reach test were done for all participants.

Results Pearson's correlation was used to analyze the collected data. The results indicated a poor correlation between FMS and fitness parameters. These are FMS and Y-balance test left and right side ($r = 0.216, 0.144$, $p = 0.084, 0.251$), FMS with Flamingo balance test left and right side ($r = 0.071, 0.197$ $p = 0.575, 0.115$), and FMS with sit and reach test ($r = 0.006$, $p = 0.961$).

Conclusion The results showed that functional movement screening and balance (Flamingo and Y balance) and sit and reach cannot be used interchangeably as they do not have any strong correlation. The results of the study also indicate that using only one of the tools cannot predict injury risk in healthy individuals. They have to be used in conjunction with each other.

Keywords Functional movement screening (FMS), Static balance, Dynamic balance, Flexibility, Y balance, Flamingo balance, Sit and reach

Background

A functional movement screening (FMS) tool was developed by physical therapists Gray Cook and Lee Burton in 1997 [1, 2]. This tool is used as an injury risk predictor, and it also detects the quality of the basic and fundamental movement patterns. FMS was created to quantify the quality of movement in any individual, but it is now mostly being used in the athletic population [3]. For every individual, fitness is an important factor to maintain good health and to perform activities of daily living (ADL) with ease. For everyday activities, balance and flexibility along with cardiovascular endurance are required more as compared to other fitness parameters [4]. Hence, in this study, static balance, dynamic balance, and flexibility are

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taken as major components, and an attempt is made to find their correlation with FMS scores. FMS, Flamingo balance test (FBT), Y-balance test (YBT), and sit and reach test (SAR) act as physical performance identifiers and injury risk predictors in otherwise healthy individuals [5]. FMS has seven fundamental movement patterns that require both stability and mobility components. It was created to quantify movement patterns based on the proprioceptive and kinesthetic awareness principle [1]. The relationship between FMS and balance has been mostly investigated in military [6], athletic population [3, 7, 8], and in university dancers [7, 9] but very sparingly in nonathletic population. Researchers have used the composite scores of the seven components of FMS but failed to use all movement patterns individually for analysis. As per recommendation of Schneiders and colleagues in their study on "Functional movement screen normative values in young, active population" in 2011 [10], an effort is made in the present study to cover all movement patterns individually, their correlation with each of the functional activities, and the gender differences.

Balance plays a vital role in ADL because it is very much needed for many daily activities like maintaining erect posture; performing daily activities like bathing, dressing up, walking, and climbing stairs; navigating through obstacles; and reacting to various external and internal stimuli [11]. Static balance helps to maintain upright posture and properly align center of gravity within base of support, whereas dynamic balance helps maintain stability during weight shifting often while changing the base of support [12]. YBT has been used extensively to measure physical readiness for an activity, and dynamic balance interventions were used to improve the lower extremity dynamic neuromuscular control which has been utilized as injury prevention strategy [13].

Flexibility relates to the length of the muscle and connective tissue to the joint structure, age, and gender [14]. Flexibility exercises may enhance postural stability and balance. Sit and reach test correlates with overall flexibility and hamstring flexibility in particular [15]. There are several studies done to find the relationship between FMS with balance and flexibility among athletes, but there is dearth of evidence to correlate FMS with balance and flexibility among healthy nonathletic individuals [8].

Hence, the purpose of this study was to evaluate the correlation of FMS scores with static balance, dynamic balance, and flexibility among healthy nonathletic population and to find if there are any gender differences.

Methods

This observational correlation study was conducted in the therapeutics laboratory of a teaching institute, to evaluate the correlation between FMS and (a) static and dynamic balance and (b) the flexibility, in healthy nonathlete population. As illustrated in the flow diagram in Fig. 1, sixty-five (40 females and 25 males) nonathletes but otherwise healthy individuals were selected for the study, from the 72 screened, based on the following selection criteria: age between 18 and 27 years, not participating in any sporting or regular training activities for at least the past 2 years, and gave consent and willingness to participate in the study. Anyone with musculoskeletal injury within the past 6 months and any history of systemic disease or vestibular disorders were excluded from the study. The participants were enrolled using non probability purposive sampling method. Informed consent was obtained prior to the assessments, from all the participants who were included in the study. Ethical clearance was obtained from the IEC of the institute before carrying out the study. Sample size has been calculated using the formula $1+ Z^2 \times p\ (1-p)/e^2N$ where N is the population size (90), e is margin of error (1.52), z is z score (1.2), and p is standard deviation (8.3) arriving at an inflated sample size of 65 to accommodate any dropouts.

Materials used for this study were FMS test kit to evaluate FMS score, rectangular wooden block for Flamingo balance test (6-cm height, 10-cm width, and 30-cm length), measuring tapes for Y-balance test, and sit and reach box for flexibility test. All participants wore comfortable clothing that did not interfere with the evaluation of the tests. Before the evaluation, the height and weight of the participants were recorded.

The functional movement screening

The FMS consists of seven tests covering basic movement patterns—deep squat, hurdle step, inline lunge, shoulder mobility, active straight leg raise, trunk stability push-up, and rotary stability. Each test was evaluated based on a 0–3 grading scale. Each participant performed each trial 3 times, and the best of the three trials was scored. A score of 3 was given when the participant performed the movement without any compensation, a score of 2 was given when the participant completed the movement with compensation, a score of 1 was given when the participant was unable to perform/complete the test movement, and 0 was scored when pain was felt while performing the movement pattern. For the movements other than deep squat and trunk stability push-up, the right and left sides were evaluated separately, the right side being evaluated first. Thus, lower of the two scores between the right and left side was finally recorded. FMS demonstrates an excellent inter-rater and intra-rater reliability of 0.81 ICC for both. According to previous research, the injury risk was high with a total score of $<$ 14 and a low injury risk when the score was $>$ 14 [16].

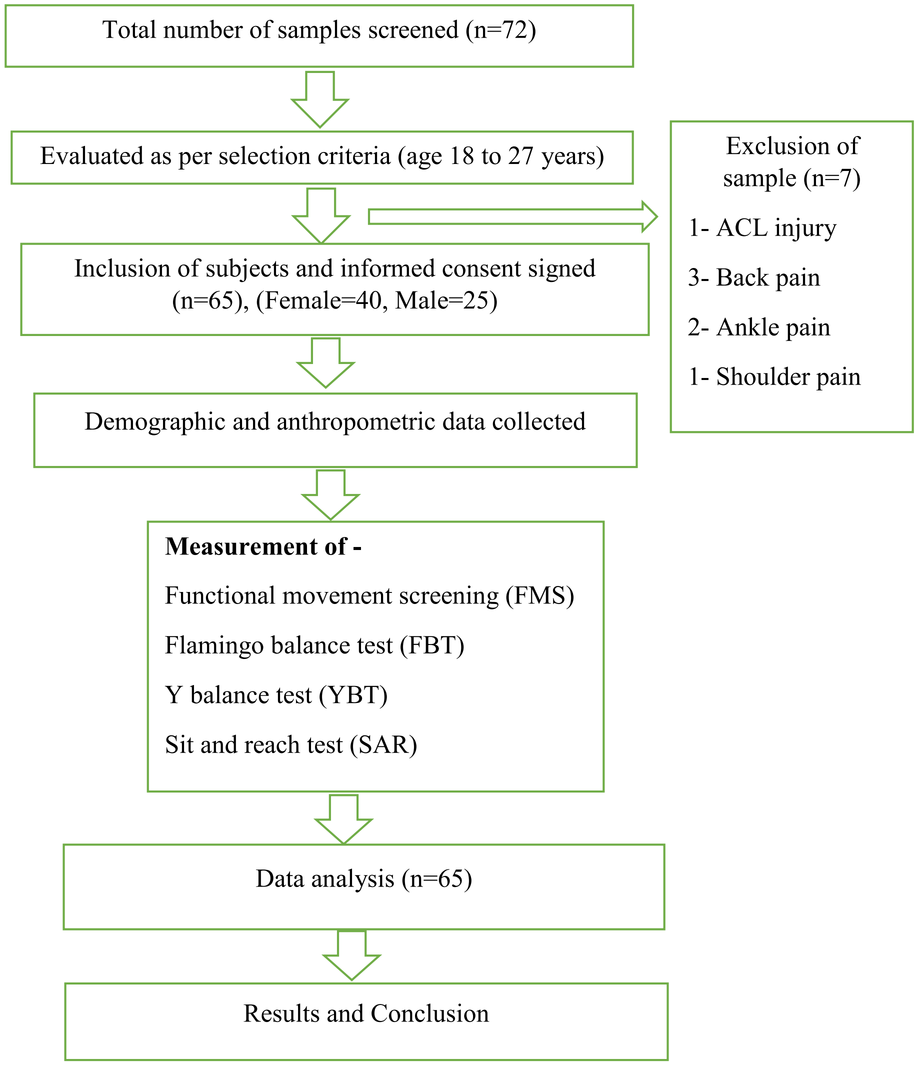

Fig. 1 Flow diagram of the study

Y-balance test

Three tapes were placed on the floor for the YBT, so as to form an angle of 90° between the two posteriorly directed tapes and the other two angles of 135° between the anterior and the posteromedial and posterolateral tapes respectively. The participant had to place one leg in the center of the three tapes and try to reach as far as possible anteriorly (Fig. 2), posteromedially, and posterolaterally (Fig. 3) with the other leg. The left and right sides were measured separately with the score corresponding to the stance leg. The scoring was calculated as the percentage of reach distance to the limb length. The test has a high interclass and intraclass reliability of 0.88 for both [17].

Flamingo balance test

The participant stood on the wooden box without shoes. To maintain balance, they were instructed to hold the unsupported ankle with the same side hand towards their buttocks (Fig. 4). Timer was started as per the instruction of the investigator. The maximal duration of hold time of the static balance posture in seconds was recorded. Any loss or deviations in posture or adjustments to the posture or fall from the wooden block indicated termination of the test. It was done separately for right and left sides. The test has a high interclass reliability of 0.73 to 0.81 [18].

Fig. 2 Y-balance test (anterior)

Sit and reach flexibility test

Participants sat on the floor with straight knees and straightened both hands trying to reach forward as much as possible and hold for 3 s and then come back to the original starting position. This was repeated three times consecutively, and the average of the three scores was taken as the final score. This test has an interclass reliability of 0.71 to 0.86 [19].

Statistical analysis

The collected data were analyzed using the statistical package SPSS 29.0 (SPSS Inc., Chicago, IL, USA). Kolmogorov-Smirnov test was used to check normality. As the data was normally distributed, Pearson's correlation test was used to correlate FMS with static balance, dynamic balance, and flexibility. The tests were applied

Fig. 3 Y-balance test (posteromedial). Y-balance test (posterolateral)

Fig. 4 Flamingo balance test

Table 1 Means and SD of demographic and outcome parameters

Variables	Mean	Standard deviation (SD)
Age	23.18	2.71
Height in cm	163.55	7.93
Weight in kg	63.70	13.03
BMI	24.13	3.95
FMS	15.16	1.74
YBTL in cm	75.98	11.95
YBTR in cm	75.46	12.02
FBTL in s	66.30	34.46
FBTR in s	66.63	47.22
SAR in cm	20.01	9.81

Table 2 Correlation between composite FMS score and YBT (left and right), FBT (left and right), and SAR

Variables	*r*-value	*p*-value
FMS and YBTL	0.216	0.084
FMS and YBTR	0.144	0.251
FMS and FBTL	0.071	0.575
FMS and FBTR	0.197	0.115
FMS and SAR	0.006	0.961

at a power of 80% and confidence interval of 95% and level of significance; *p*-value was set as < 0.05.

Results

The analyzed data were tabulated and the results interpreted as follows (Table 1):

Composite FMS score with right and left Y-balance test correlation analysis indicated a poor correlation between FMS and right and left Y-balance test. FMS score with left and right Flamingo balance test analysis indicated a poor correlation between FMS and left and right Flamingo balance test. FMS and sit and reach test analysis also indicated a poor correlation between the two, with all correlations statistically insignificant (Table 2).

All the FMS components score with the sit and reach test correlation analysis indicated a poor correlation between FMS and SAR, but there was a moderate to good correlation between SAR and active straight leg raise of FMS both on the right and left sides (Table 3).

The right FMS component and left-side balance analysis with the Pearson correlation test indicated a poor correlation between the two (Table 4).

Table 3 Correlation between the flexibility components of FMS and SAR

Component of FMS	SAR (*r*-value)	*p*-value
Deep squat	0.048	0.730
Left shoulder mobility	0.170	0.175
Right shoulder mobility	0.170	0.175
Left straight leg raise	0.270	0.029
Right straight leg raise	0.270	0.029

Table 4 Correlation between right-side FMS balance components and left-side balance

Component of FMS	YBTL (*r*-value)	*p*-value	FBTL (*r*-value)	*p*-value
Right rotary stability	0.063	0.617	0.115	0.363
Right in line lunge	0.240	0.054	0.031	0.093
Right hurdle step	0.145	0.248	0.093	0.462

Table 5 Correlation between left-side FMS balance component and right-side balance

Component of FMS	YBTR (*r*-value)	*p*-value	FBTR (*r*-value)	*p*-value
Left rotatory stability	0.057	0.652	0.102	0.420
Left in line lunge	0.235	0.060	0.074	0.556
Left hurdle step	0.150	0.232	0.143	0.256

Table 6 Gender difference FMS composite score with balance and flexibility

Variables	Female *r*-value	Female *p*-value	Male *r*-value	Male *p*-value
FMS and YBTL	0.229	0.160	0.083	0.693
FMS and YBTR	0.257	0.115	0.277	0.181
FMS and FBTL	0.092	0.580	0.082	0.696
FMS and FBTR	0.188	0.253	0.501	0.011
FMS and SAR	0.076	0.646	0.051	0.810

The left FMS component and right-side balance turned up with a poor correlation between left FMS and right-side balance (Table 5).

In both male and female, the composite FMS score with right and left YBT, FBT, and SAR correlation indicated a poor correlation between FMS and balance and flexibility except for composite FMS score with FBTR in male participants which showed good correlation (Table 6).

Table 7 FMS individual components correlation with SAR in male and female

Component of FMS	Female SAR (r value)	*p*-value	Male SAR (*r*-value)	*p*-value
Deep squat	0.090	0.587	0.071	0.735
Left shoulder mobility	0.179	0.275	0.182	0.384
Right shoulder mobility	0.179	0.275	0.182	0.384
Left straight leg raise	0.308	0.056	0.071	0.734
Right straight leg raise	0.308	0.056	0.071	0.734

In both male and female, FMS components with SAR correlation tests indicated poor correlation between FMS individual components and SAR in both genders (Table 7).

In both male and female, right-side FMS components scores and left-side balance analysis with the Pearson correlation test indicated poor correlation between right FMS and left-side balance but there is good correlation between YBTL and right rotatory stability alone in males (Table 8).

In both male and female, right FMS component and left-side balance analysis with the Pearson correlation test indicated a poor correlation between right FMS and left-side balance. There was good correlation between left rotary stability with YBTR, and fair correlation between left in line lunge with FBTR both in male participants only (Table 9).

Discussion

This study aimed to find out the relationship of FMS with fitness parameters, balance, and flexibility. The results of this study showed a poor correlation between FMS and the fitness components, which indicates that there is no relationship between the composite FMS score with balance and flexibility in non-athlete adult population. A previous study also showed that in adolescents, the athletic performance with FMS score had weak and moderate correlation, and FMS score had no association with flexibility [20]. Studies by Damina Sikora et al. and Taylor A. Kramer et al. found that FMS was weakly correlated with the Y-balance test in young football athletes [5, 8]. Few studies done to establish a correlation between composite FMS score and dynamic balance and flexibility in athletic populations [3, 21] concluded positive relationship between them. Studies on FMS showed that in-line lunge and hurdle step correlated well with balance, because the stability component works more, as neuromuscular control is required to keep a person balanced, while deep squat, shoulder mobility, and active straight leg raise require flexibility to perform the movement smoothly [1, 2].

Apart from the active straight leg raise component of FMS having good correlation with the SAR, both mimicking similar movement patterns, none of the other components of FMS correlated with the balance or flexibility tests. This is a clear indication that FMS and balance (YBT and FBT) and flexibility cannot be used interchangeably in non-athlete population as they do not have any strong correlation. This also strengthens the notion that FMS and YBT measure different aspects of movement competency [9]. The present study also suggests that using only one of the tools cannot predict injury risk in healthy individuals. They have to be used in conjunction with each other.

It has to be noted that there was not much of a differentiation in the statistics between male and female participants. The composite FMS score showed good correlation with FBTR in male participants. As far as individual components of FMS were concerned, the YBTR correlated well with the rotary stability left side, and the

Table 8 Correlation between right-side FMS balance components and left-side balance in male and female

Component of FMS	Female YBTL	*p* value	Male YBTL	*p* value	Female FBTL	*p* value	Male FBTL	*p* value
Right rotary stability	0.087	0.598	0.589	0.002	0.138	0.401	0.094	0.655
Right in line lunge	0.264	0.105	0.041	0.845	0.011	0.949	0.108	0.608
Right hurdle step	0.255	0.117	0.301	0.589	0.025	0.880	0.311	0.130

Table 9 Correlation between left-side FMS balance components and right-side balance in male and female

Component of FMS	Female YBTR	*p*-value	Male YBTR	*p*-value	Female FBTR	*p*-value	Male FBTR	*p*-value
Left rotatory stability	0.047	0.776	0.447	0.025	0.288	0.075	0.312	0.129
Left in line lunge	0.269	0.098	0.218	0.296	0.269	0.098	0.399	0.048
Left hurdle step	0.037	0.825	0.283	0.171	0.243	0.136	0.394	0.051

YBTL showed good correlation with the rotary stability right side indicating that the Y-balance test and the rotary stability in male participants can be used in similar fashion. Also, the left in line lunge showed fair correlation with YBTR in male. Otherwise, both male and female participants showed similar noncorrelation results.

This study was limited to non-athlete young adults, most of whom were college students. The normative values of flexibility and balance using these specific tests were not taken into consideration. Balance and flexibility tests other than those performed in this study could have shown correlation with FMS. Further studies with other fitness tests could be performed to find the correlation of FMS with those test parameters. This study was performed on young individuals. Further studies can be performed among healthy injury-free middle-aged and older population. Studies comparing the FMS scores to normative values of various fitness components among non-athlete collegiate population can also be done.

Conclusion

It can be concluded from the results of this study that there is a poor correlation between composite FMS score and static balance, dynamic balance, and flexibility. Most of the individual components of FMS also have a poor correlation with balance and flexibility. These results may indicate that neither the composite FMS score in isolation nor the individual scores of the seven FMS components can be used as a predictor for balance or flexibility (except the active straight leg raise) in healthy nonathletic individuals, as there is no statistical correlation between them. Nevertheless, FMS score can still be used as an injury risk predictor as can balance and flexibility scores in conjunction with each other.

Abbreviations

FMS	Functional movement screening
YBT	Y-balance test
FBT	Flamingo balance test
SAR	Sit and reach test
YBTL	Y-balance test left side
YBTR	Y-balance test right side
FBTL	Flamingo balance test left side
FBTR	Flamingo balance test right side

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s43161-023-00151-w.

Additional file 1.

Authors' contributions

CM contributed to the manuscript, review of manuscript, collection, and analysis of data. JORA contributed in conception of the study, manuscript, and review of manuscript.

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Availability of data and materials

The data collected and/or analyzed during the study are available with the corresponding author.

Declarations

Ethics approval and consent to participate

The study was done at Abhinav Bindra Sports Medicine and Research Institute, Bhubaneswar, Odisha, India. Ethical clearance was taken from the ethical committee of the institute, and informed consent was taken from all the participants. The study is not a clinical trial, so no clinical trial registration was done. The participants were aware of all procedures involved in the study, and a written consent was taken for the same.

Competing interests

The authors declare that they have no competing interests.

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