

# Research Paper: Functional Movement Screen in Elite Boy Basketball Players: A Reliability Study



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## ABSTRACT

**Purpose:** To investigate the reliability of Functional Movement Screen (FMS) in basketball players. A few studies have compared the reliability of FMS between raters with different experience in athletes. The purpose of this study was to compare the FMS scoring between the beginners and expert raters using video records.

**Methods:** This is a cross-sectional study. The study subjects comprised 15 elite boy basketball players. The subjects were randomly selected and each of them completed FMS tests. Three examiners (two beginners and one expert) watched the recorded video separately and scored the tests. We used the Kinovea video-analysis software for data analysis. The test-retest reliability was assessed using Intra-Class Correlation Coefficients (ICCs). Also inter-tester reliability of each test was computed using Fleiss' kappa test.

**Results:** The mean (SD) total FMS score for rater 1, rater 2, and rater 3 were 14.17(1.26), 14.17(1.94), and 13.67(1.67), respectively. There was no significant difference between examiners with respect to total FMS score ( $P=0.136$ ). Half of the individual FMS components had perfect agreement, and rest were categorized as moderate to substantial agreement. The high and moderate values of ICC as 0.88~0.99 and 0.71~0.91 were observed for intra-rater and inter-rater reliability, respectively.

**Conclusion:** The examiners reported FMS total scores similarly. The inter-rater reliability for the test components had strong agreement. This finding suggests that FMS can be used in the evaluation of the abnormal movement patterns of the athletes.

## Keywords:

Functional movement screen, Reliability, Basketball

## 1. Introduction

Pre-participation physical examination is well proposed as a part of the international sport programs and used to identify possible risk factors leading to disease and injury such as sudden cardiac death, cardiovascular disease, and particular musculoskeletal disorders [1-4].

Generally, pre-participation screening methods can be used to evaluate the health condition prior to participation in competition. It focuses on factors that could identify particular athletic talents or predispose athletes to injury [5-9].

Some researchers have reported several intrinsic and extrinsic risk factors, including muscle strength, structural malalignments, sex, postural sway, fitness level, and his-

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tory of previous musculoskeletal injury that predispose athletes to injury [10-12]. Additionally, poor neuromuscular control, weak core stability, and muscular asymmetries have been proposed as other risk factors for injury. Contralateral muscle imbalances may lead to muscular inhibition and compensatory strategies [13].

Functional Movement Screen (FMS) is an effective method that quantitatively measures movement patterns to detect performance asymmetries [14]. Health experts and coaches use FMS to screen the athletes at risk of injury with identification of the asymmetry and abnormal movements [15]. Although FMS has widely been used clinically for evaluating of the muscular asymmetries and flexibility deficits, there is little information or investigation about the FMS reliability in athletes. In addition, the traditional sports medicine methods have focused on specific joints and muscles, but new methods like FMS evaluate functional movement.

FMS could help to identify the athletes at risk of injury and affect the recovery of the injured athletes. At the present time, there is no agreement that which factors are required for the return of the athletes to the sports [16]. However, resume to normal sport activity needs the sensory perceptual motoric integration [7].

It seems that the traditional pre-participation screening methods does not provide the adequate baseline information to assess the individual's preparedness, without evaluating the basic aspects of human movements [7]. Movement screening should be performed with specific performance assessments, since the main objectives of the pre-participation screening are reducing injuries, increasing performance, and promoting the quality of movements.

There are two various classifications of reliability measurement, including intra-rater reliability and inter-rater reliability. The first category of reliability evaluates how well each examiner or rater can frequently or consistently obtain the similar resulting score. In the second reliability category, the examiners are more than one and the degree of agreement compute the extent to which the examiners get the similar resulting score, when they look at the same subject [14].

Few researchers have investigated the inter-rater reliability of the FMS score. Schneiders et al. reported the high reliability between two examiners with the similar level of experience. Also, Minick et al. have reported the high reliability between raters with the same level of experience [5, 17]. Smith et al. have examined reliability of FMS scoring among participants with various levels of experience and obtained high reliability [18]. In

a similar study, Gribble et al. investigated the inter-rater reliability between examiners with various level of clinical experience and reported moderate reliability between examiners [19]. In both studies, subjects were healthy populations and few studies have evaluated the FMS reliability in athletes. Therefore, the purpose of this study was to evaluate the inter-examiner reliability of the FMS score among beginners and expert examiners.

## 2. Materials and Methods

### Participants

This study had a cross-sectional design. Study population comprised the elite boy basketball players of Hamedan City in 2015 and out of them, 15 subjects were selected randomly. Subjects were injury free at the time of the tests. Assessment protocol was explained to the study subjects. Three raters, including one expert (expert in sport injury and corrective exercise with 2 years' regular experience at working with FMS) and 2 novices (graduated physical education students) scored the FMS performed by the subjects. An informed consent approved by the Bu-Ali Sina University Ethics Committee was signed by all subjects. Sample size was calculated using G power software ( $\alpha$  level of 0.05, a power of 80%, and effect size of 0.5).

### Procedures

All subjects performed FMS tests. The FMS included seven tasks to evaluate functional movement ability [7]. The subjects performed these seven tasks as a standard sequence, including overhead squat, hurdle step, in-line lunge, shoulder mobility, active hamstrings flexibility, trunk, and rotary stability test. Also, subjects performed three clearing tasks (lumbar flexion, lumbar extension, and shoulder medial rotation) which evaluate pain. Five of these seven tasks assessed the asymmetry by comparing both sides [20].

The participants performed dynamic warm up before assessments and then executed seven FMS tasks. They were received particular instructions about how properly perform each task. Feedback during the test was prohibited and athlete's movements were recorded by 2 digital video cameras (model PC-1262, Canon) positioned in the sagittal and frontal planes (30 frame/second). All subjects performed each task two times. Kinovea video-analysis software version 0.8.15 was used for data analysis.

Three raters scored the test two month later. One of the raters (expert) rescored the video after a week for computing intra-tester reliability [18]. According to the quality of movement, each task was scored from 0 to 3. The score of

**Table 1.** The Fleiss' kappa scores

Score	Criteria
Excellent	80% and higher
Substantial	60% to 79.9%
Moderate	40% to 59.9%
Poor	Below 40%

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3 was given to the participant who was able to execute each task without compensatory motion. The participant, who performed the task with compensation motion received a score 2. The score of 1 was given to the participant who was unable to obtain the position to perform task. The participant, who experienced pain during the task, received a 0 score. The total score was computed by summation of each task score, which ranged from 0 to 21 [7, 16].

**Statistical analysis**

Data were analyzed by SPSS 20. The Shapiro-Wilks test was used to assess the data normality distribution. The ICC (Intraclass Correlation Coefficients) was utilized to compute the inter- and intra-rater reliability of total FMS scores. The ICC value changes from 0 to 1 [21]. The inter-tester reliability of each task was assessed by the Fleiss' kappa (Table 1).

**3. Results**

Table 2 presents the demographic information of the subjects. The mean (SD) total score of FMS in all examiners is about 14.06(1.6). Table 3 shows the mean (SD) scores of total FMS and its components for each rater. The ICC value for total scores was 0.87(0.71~0.91) which demonstrates good to excellent agreement between examiners (Table 4). In 12 individual tests, five tests exhibited excellent agreement between the raters, three tests substantial agreement, three tests moderate agreement, and one test poor agreement (Table 5).

**Table 2.** Demographic information of subjects

Variable	Mean±SD
Age (y)	16.33±0.65
Height (cm)	181.75±10.03
Weight (kg)	69.50±0.13
Experience (y)	6.25±1.54

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**4. Discussion**

The study findings indicate no significant difference in total FMS scores between raters. On the contrary, the ability of three raters in FMS scoring was similar. Also, the total FMS scores of the three evaluators showed excellent correlation. This is in agreement with earlier research. There is a high correlation between the raters in total FMS scoring based on Schneiders et al. study [5]. In addition, Smith et al. and Onate and Dewey reported high inter-rater reliability in their studies [18, 22]. The mean total FMS score of the present study is similar to the findings of Smith et al. and Chorba et al. studies [13, 18].

We also evaluated inter-rater reliability of the test components and half of the FMS tests showed good agreement based on the study results. Our results are in agreement with previous research on FMS reliability. Minick et al. found significant to good inter-rater agreement on each FMS component scores when compared 2 beginners and 2 experts [17]. Moreover, the finding of this study indicated that right in-line lunge task had the minimum reliability and right active leg raise task, the maximum reliability. This result is consistent with previous studies [23]. Onate and Dewey reported that right leg raise test had the lowest inter-rater reliability [22] whereas this task in the present study showed 100% agreement. FMS is a noninvasive tool to assess asymmetry of movement abilities in athletes. The importance of this test is that coaches, athletes, and trainers can learn this test as a useful method for evaluating fundamental movement patterns.

**Table 3.** Mean±SD of total and component FMS scores by all raters

Test	Rater 1	Rater 2	Rater 3
Deep squat	2.17±0.718	2.25±0.622	2.17±0.718
Right hurdle step	1.92±0.515	1.92±0.515	2.00±0.603
Left hurdle step	2.00±0.426	1.92±0.289	2.00±0.426
Right in-line lunge	2.17±0.389	1.92±0.289	2.33±0.492
Left in-line lunge	2.08±0.515	2.00±0.426	2.17±0.577
Right shoulder mobility	2.17±0.835	2.25±0.754	2.17±0.835
Left shoulder mobility	2.25±0.754	2.33±0.651	2.00±0.853
Right hamstring flexibility	2.17±0.718	2.17±0.718	2.17±0.718
Left hamstring flexibility	2.17±0.577	2.25±0.622	2.17±0.577
Trunk stability	2.08±0.669	2.17±0.718	1.92±0.793
Right rotary stability	1.92±0.515	1.83±0.577	1.83±0.452
Left rotary stability	2.00±0.426	2.08±0.289	2.00±0.426
Total FMS score	14.17±1.26	14.17±1.94	13.67±1.60

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**Table 4.** Reliability of total FMS Scores

Variable	ICC	95% CI
Intrarater (test-retest)	0.96	0.88, 0.99
Interrater	0.87	0.71, 0.91

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**Table 5.** Agreement of FMS individual test scores (0-3 points)

Test	Kappa	SE	95% CI	Agreement
Deep squat	0.90	0.127	0.65, 1.15	Excellent
Right hurdle step	0.87	0.1272	0.62, 1.12	Excellent
Left hurdle step	0.55	0.1304	0.29, 0.80	Moderate
Right In-line lunge	0.05	0.1477	-0.23, 0.34	Poor
Left In-line lunge	0.72	0.1307	0.46, 0.98	Substantial
Right Shoulder mobility	0.91	0.1202	0.67, 1.14	Excellent
Left Shoulder mobility	0.65	0.1219	0.41, 0.89	Substantial
Right hamstring flexibility	1	0.124	0.75, 1.24	Excellent
Left hamstring flexibility	0.89	0.135	0.62, 1.15	Excellent
Trunk stability	0.55	0.1206	0.31, 0.79	Moderate
Right rotary stability	0.73	0.14	0.46, 1.01	Substantial
Left rotary stability	0.55	0.1304	0.29, 0.80	Moderate

CI: Confidence Interval

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We suggest that future studies compare the reliability of real-time and video recorded scoring of the FMS. The real-time scoring system provides quicker feedback on the test execution and decreases the time needed for data interpretation. Since video analyzing and FMS scoring is time consuming, professionals do not use it in the training and games. Real time analysis is more applicable to give effective and rapid feedback to majority of the participants.

The present study supports the reliability of FMS test, which is used to evaluate dysfunction and asymmetry of movement. In addition, the finding of this research indicates that total FMS score is reported similarly between the raters, while the reliability of some test components are not suitable for evaluating the functional movement, especially in raters with different experiences. The functional movement screening methods mainly affect the measures taken for injury prevention and performance enhancement.

The limitation of the present research is the small sample size. Also the raters could observe the video records of participant's FMS test without any restrictions. This limitation in video analysis may affect raters' scoring.

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#### Conflict of Interest

The author declared no conflicts of interest.

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