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# The Role of a Functional Movement Screen Test in Predicting Sports Injuries in three-Person Basketball Athletes

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ABSTRACT

**Background:** It is important to screen athletes before the competition season to identify those at risk of injury. Three-person basketball is a team sport where injury risks should be closely monitored. The present study investigates the role of the Functional Movement Screen (FMS) test in predicting sports injuries in three-person basketball athletes.
**Methods:** A cross-sectional study was conducted on 50 male athletes (22 athletes with injuries and 28 athletes without injuries) with an average age of 25.58±3.83, weight of 76.64±6.23, and height of 184.18±6.55. Multiple logistic regression analysis was performed to investigate the factors related to injury. SPSS software was used for data analysis, with a significance level of $P<0.05$.
**Results:** The multiple logistic regression model showed a strong association between the FMS functional screening test and injury. The risk of injury decreased significantly with higher scores on the FMS functional screening test ($P<0.05$). The FMS functional screening test's adjusted odds ratio (OR) was 0.673.
**Conclusion:** The results indicate that the FMS test can identify athletes more prone to injury in team-neighborhood and championship sports. Coaches and athletes are suggested to use FMS tests in neighborhood disciplines such as three-person basketball to predict and develop more targeted sports injury prevention programs.



## Introduction

Sports, healthcare, and health professionals have long sought to help athletes maximize performance and prevent injury, but methods to predict performance and reduce injury risk have inherent limitations [1]. Basketball is one of the most popular sports in the world, with more than 825 million followers. Three-person basketball, also known as streetball, is played on the streets. The International Amateur Basketball Federation (FIBA) surveyed young people to determine the most popular leisure sports in urban areas, and "3 on 3" basketball was one of the sports identified. This sport can be played without expensive equipment and provides an opportunity for a wide range of young people and girls to play, mainly in school gymnasiums and outdoor playgrounds [2, 3].

The impact of basketball injuries can be devastating, affecting not only the athlete but also their team and family [3]. These injuries can hinder athletes from training and competing at their best and in severe cases, may even lead to disability or pose life-threatening risks [4]. Additionally, injuries can impose psychological burdens on athletes and impede their progress in sports [2]. Therefore, conducting in-depth studies on preventing basketball sports injuries is crucial. While there are

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various reasons for sports injuries, prevention is always emphasized. However, it can be challenging for athletes to avoid injuries, especially when they engage in excessive play. Therefore, educating students on how to prevent sports injuries in basketball is essential for promoting the development of basketball and maintaining the health of basketball players [5].

Sports injuries impair athletes' ability to compete at all levels. According to a study by Sheu Y et al., 8.6 million sports and recreation-related injuries occur annually in the United States, equating to 34.1 injuries per 1000 people [6]. The study of basketball sports injuries warrants thorough examination to prevent them. While prevention is constantly stressed, athletes may occasionally overexert themselves, making it challenging to avoid basketball-related injuries. Screening is conducted to mitigate harm and enhance the efficacy of implementation strategies [7]. One screening model that attempts to predict injury risk is the Functional Movement Screen (FMS), which Cook et al. (2006) developed as a screening tool considering preseason screening and performance-related factors. FMS can be used to assess the risk of musculoskeletal injury in unspecified sports populations [8].

FMS is a tool designed to demonstrate a sequence of movements that help recognize underlying compensatory movement patterns, functional limitations, and asymmetric movement patterns. A prior systematic review and meta-analysis have indicated that athletes scoring below 13-14 on the FMS are classified as "high-risk" and are more likely to experience injuries [9]. Some authors claim that the FMS is one of the popular on-site sports medicine screenings and is capable of identifying players at risk of injury [10]. These assessments aid in identifying dysfunctional or compensatory motor tendencies, which are valuable after rehabilitation to assess the athlete's readiness to return to physical activity. Screening interests injury researchers, physical therapists, coaches, strength and conditioning specialists, and sports medicine professionals [11, 12].

This set of tests is designed to assess mobility and stability using seven movement tests simultaneously. The set can be completed in 5 to 10 minutes, making it convenient for coaches to use for pre-season evaluations. The seven tests include deep squats, stepping over an obstacle, lunges, shoulder mobility, active leg raising, trunk stability swimming, and rotational stability [8]. According to research, an athlete who scores less than 14 on this test is four times more prone to injury. The maximum score on this test is 21, and a score below 14 indicates susceptibility to injury [8, 13]. The FMS test has garnered significant attention recently, and studies have consistently shown it as a reliable tool [14]. However, the scientific evidence for the FMS regarding its validity for predicting injuries in sports, which is the purported purpose of the tool, is lacking, and screening is less clear [15]. The FMS test was crafted to be swift, non-invasive, cost-effective, and simple to conduct. In practical settings, it is crucial to showcase that FMS training enhances FMS scores, diminishes the incidence of injuries, and reduces the time lost [16]. Nevertheless, limited studies have documented the injury prevention efficacy of FMS training. Prior research has underscored the significance of pre-season screening and identifying athletes vulnerable to injury. Our study aimed to ascertain the predictive value of a functional screening test in forecasting sports injuries among three-person basketball athletes. We hypothesized that subpar performance on the test during preseason screenings correlates with a heightened risk of sports injuries in three-person basketball players.

## Methods

This study was approved by the Ethics Committee of the Hamadan University of Medical Sciences (Code: IR.UMSHA.REC.1400.493). An information collection form was utilized to select the subjects for the study. This form included personal characteristics such as height, weight, age, sports, playing history, injury history (including injury mechanism and the body part involved), and the amount of physical activity per week. The information collected through this form determined eligibility based on the entry criteria. The inclusion criteria for the study were active athletes aged 20-25 years with no chronic musculoskeletal diseases [17]. The exclusion criteria encompassed participants with no recent history of direct trauma to the neck or upper limb in the past month, lower limb injury within the last six months, a record of drug intake impacting neuromuscular function, and acute or specific pains impeding the test procedure [18]. Subsequently, informed consent was obtained from the subjects.

During the test session, participants were initially provided with written explanations of how to perform the tests. The tests were conducted after a 5-minute warm-up comprising stretching, dynamic movements, and light running. The following tests were administered: Y test, deep squat, step over the obstacle, lunge, shoulder movement, active straight leg raise test, trunk stability swimming test, and exposure test. Refer to Figures 1-11 for details.

**Y test**: The Y test, based on the star balance test, is considered a valid assessment for evaluating dynamic balance, as noted by Krombholz [19]. Pilsky reported inter-examiner reliability coefficients ranging from 85% to 91% for different directions and 99% to 1.00 for the total score, while intra-examiner reliability coefficients were reported as 91% and 99%, respectively [20].

**Deep squat test:** In the deep squat test, participants maintained the upper body parallel to the tibia, with thighs parallel to the ground. The knees were positioned directly above the feet, and the bar was parallel to the ground.

**Obstacle step test:** During the deep squat test, participants ensured that the hip joints, knees, and ankles were aligned in the same direction as the sagittal plane, with no movement in the waist area. Additionally, the bar and the barrier used in the test were kept parallel.

During the lunge test, participants maintained contact between the bar and the spine in the open position, with no movement in the trunk. Both the bar and the legs remained in the sagittal plane, and the knee touched the back heel of the front leg.

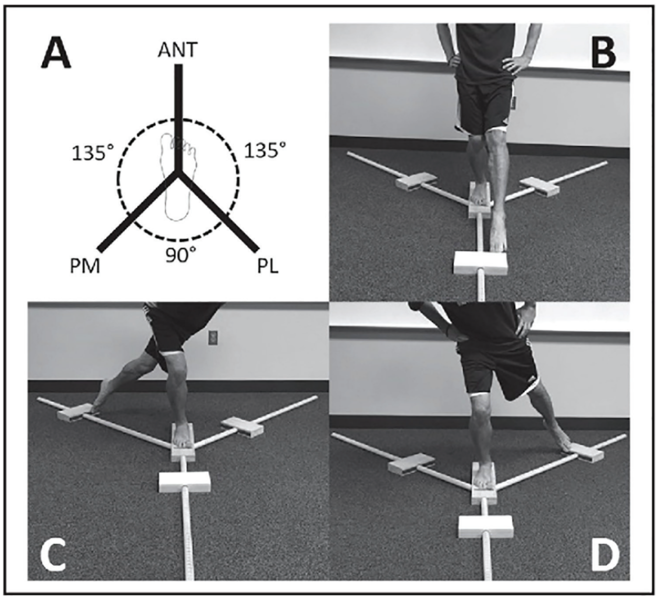


**Figure 1:** The Y Balance Test (YBT)

**Figure 2:** Deep squat test


**Figure 3:** Obstacle step test

**Figure 4:** Lounge test

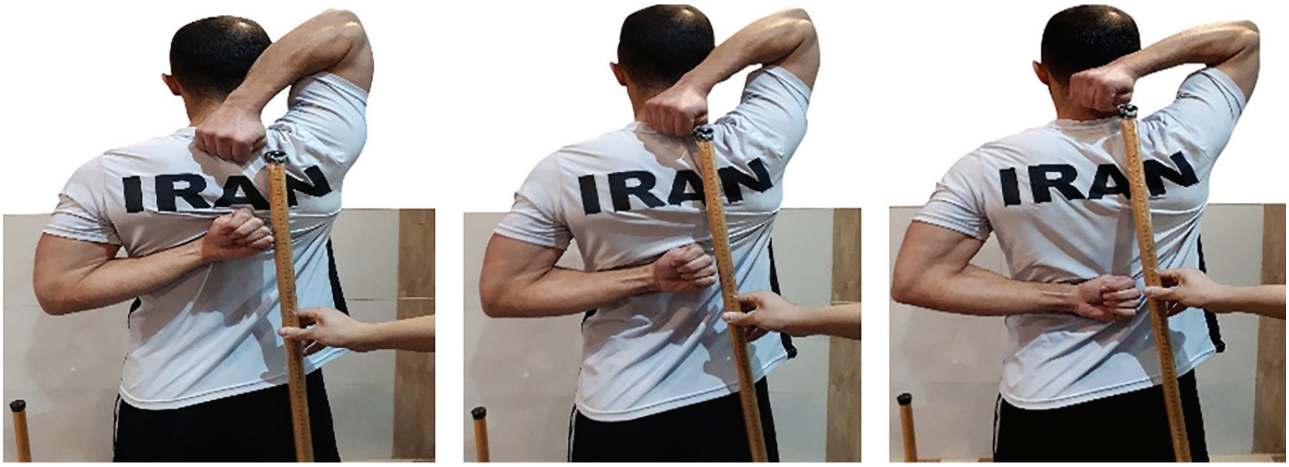


**Figure 5:** Shoulder mobility test


**Figure 6:** Detection test

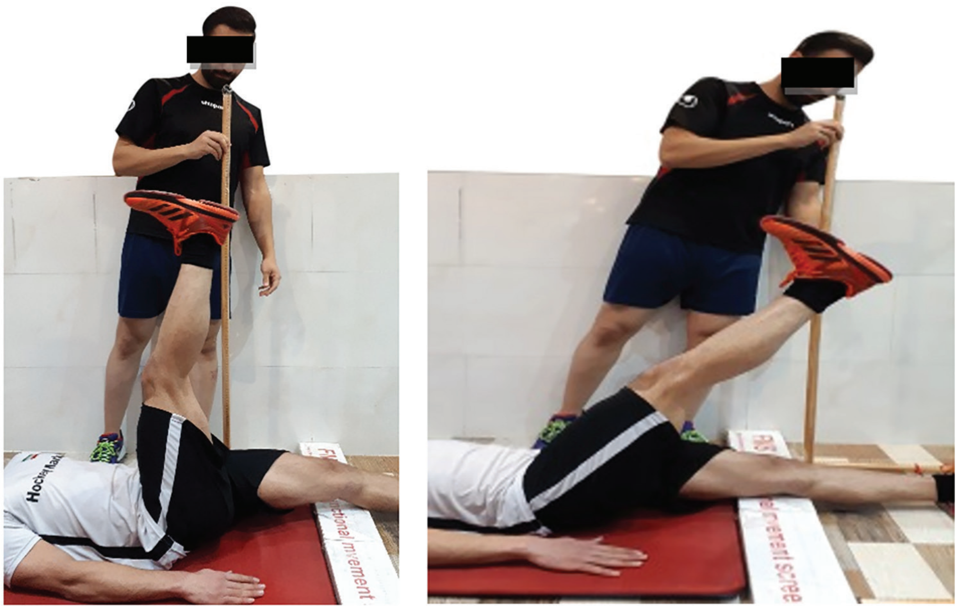

**Figure 7:** Active direct leg-raising test

*Data Analysis*

Multiple logistic regression analysis was conducted to explore the factors associated with injury. The dependent variable, "injury," was categorized into "injured" and "uninjured." The independent variables included upper limb balance, lower limb balance, and the FMS functional screening test. Adjusted odds ratios (OR) were presented to examine the relationship between these variables and injury. All statistical analyses were carried out at a significance level of 0.05 using SPSS software, Version 24.

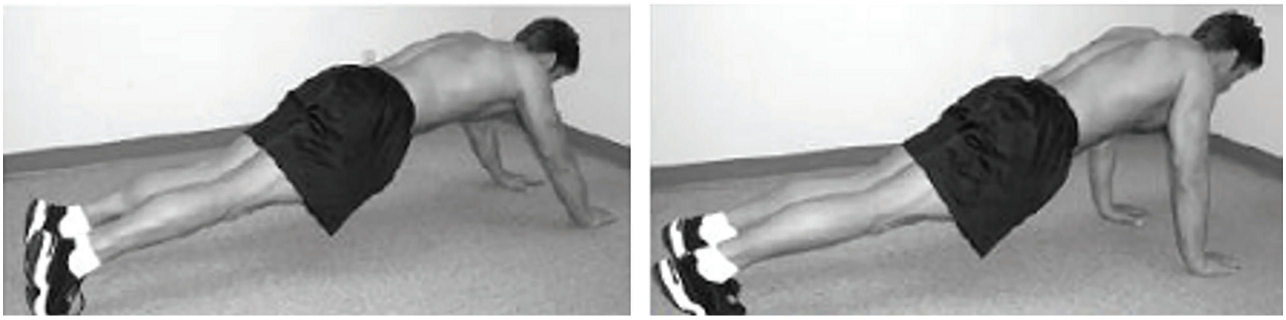

**Figure 8:** Trunk stability swimming test

**Figure 9:** Detection test for trunk stability swimming

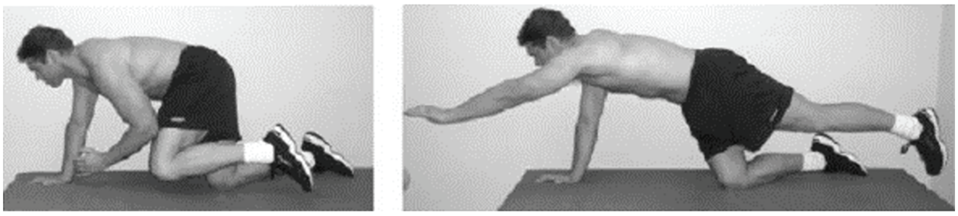

**Figure 10:** Rotational stability test

**Figure 11:** Detection test for rotational stability of the trunk

**Table 1:** Characteristics of male athletes participating in the study

| Variable | Mean | Standard Deviation |
|---|---|---|
| Age | 25.85 | 3.83 |
| Weight | 76.64 | 6.23 |
| Height | 184.18 | 6.55 |

## Results

This study involved 50 male athletes with an average age of 25.58±3.83 years, a weight of 76.64±6.23 kg, and a height of 184.18±6.55 cm (Table 1).

Of these, 22 athletes had injuries, while 28 did not. Table 2 shows the mean (standard deviation) balance of the upper limb, lower limb, and FMS.

Table 3 presents the results of the multiple logistic regression model. There was an indirect association between upper and lower extremity balance and injury. However, this association was statistically non-significant (P>0.05). The adjusted odds ratios (OR) of the upper and lower extremity balance were 0.853 and 0.889, respectively.

**Table 2:** Statistical indices related to the research variables by separating injured and uninjured basketball players

| Variables | Group | Mean | Standard Deviation |
|---|---|---|---|
| Upper extremity balance | Un injury | 87.02 | 4.97 |
| | Injured | 80.57 | 5.33 |
| Lower extremity balance | Un injury | 93.42 | 6.89 |
| | Injured | 85.99 | 6.52 |
| FMS | Un injury | 18.03 | 6.55 |
| | Injured | 13.59 | 3.01 |

FMS: The Functional Movement Screen

**Table 3:** The odds ratio (OR) estimates of injury by different variables using a multiple logistic regression model

| Variable | Adjusted (OR) | Coefficient | Standard Error | P value |
|---|---|---|---|---|
| Upper extremity balance | 0.853 | -0.159 | 0.090 | 0.080 |
| Lower extremity balance | 0.889 | -0.117 | 0.070 | 0.093 |
| FMS | 0.673 | -0.396 | 0.177 | 0.025 |

OR: The adjusted odds ratio; FMS: The Functional Movement Screen

In contrast, there was a notable correlation between the FMS functional screening test and injury. Consequently, the risk of injury substantially decreased with higher FMS functional screening test scores (P<0.05). The FMS functional screening test's adjusted odds ratio (OR) was 0.673.

## Discussion

This study aimed to examine the impact of upper limb balance, lower limb balance, and FMS functional screening test on the likelihood of injury and to forecast injuries among three-person basketball players using FMS scores. The results demonstrated significant differences in the upper limb balance, lower limb balance, and FMS functional screening test variables between the two groups of injured and uninjured basketball players. As anticipated, the effect of FMS on the probability of injury was found to be negative, with basketball players with lower FMS scores having a higher likelihood of injury than those with higher FMS scores. This finding aligns with previous studies indicating that injured athletes have lower FMS scores than healthy players.

Moreover, this study aimed to compare sports-specific performance tests between young basketball and football athletes, analyze the risk of sports injuries and their occurrence, and evaluate participants using the speed, vertical jump, agility, and plate FMS tests. Significant inter-group differences were observed in the speed, agility, and FMS tests. Over a one-year follow-up, the incidence of sports injuries was recorded, revealing a significant association between FMS scores and the occurrence of high sports injuries [21].

The study by Šiupšinskas et al. aimed to determine whether performance tests could predict sports injuries in elite female basketball players. They reviewed 351 data entries for professional female basketball players from the 2013-2016 season and scrutinized pre-season performance attributes. Functional performance evaluations were employed to gauge injury susceptibility, with data from 169 players being analyzed: 77 of whom completed the season unscathed, comprising the injury-free cohort, while 92 encountered lower limb sports injuries throughout the season, composing the injured cohort. The injury group exhibited a significantly lower FMS total score (P=0.0001) and total score (P=0.028) than the non-injury group. Suboptimal functional movement patterns and inadequate jumping-landing biomechanics identified during pre-season assessments were linked to lower limb injuries in elite female basketball players, mirroring the findings of our study. Finding the balance between maximizing performance and preventing injury is challenging in many professional sports. Identifying the risk of injury and implementing preventive measures can help reduce the occurrence of injury and potentially improve athletic performance. Improper movement patterns often cause musculoskeletal injuries (MSK). However, the validity of the FMS as an injury prediction tool for athletes is still unclear [22].

Several studies have failed to demonstrate such relationships in professional players. Hoover et al.'s study aimed to evaluate the relative risk of non-contact injuries in professional basketball players based on predictive scores in the FMS. The study involved thirty-two professional basketball players from the National Basketball Association (NBA) and the Women's National Basketball Association (WNBA). Each participant was evaluated and scored using the FMS during the training camp. Their injuries were tracked throughout the season, recording the number, type, and time lost due to injury. The potential exposure, actual exposure, and missed exposure attributable to non-contact injury (NCI) were computed for each athlete to ascertain the raw and specific incident rates for missed exposure due to NCI. Non-contact injury (NCI) was quantified per 1000 exposures. The outcomes of this investigation revealed that the FMS did not correlate with injury metrics in this subset of professional basketball players, suggesting that the tool lacked predictive validity within this demographic. These findings contrasted with those of our study [23].

The research by Schroeder et al. aimed to explore the link between injuries among male amateur football players and the outcomes of the FMS. The study encompassed ten amateur teams comprising 96 players assessed over the preceding ten weeks and throughout the primary season, with injuries documented during training and competitive events. The injury rate was calculated at 6.8 injuries per 1000 hours of training. No notable distinctions were noted between injured and uninjured players across all seven stages of the FMS and its cumulative score, except for the stage involving stepping over the obstacle, which exhibited a significant association with injury. Consequently, the researchers concluded that the FMS was not suitable for predicting injuries among amateur male soccer players [24].

Quick detection of asymmetries, movement defects, and stability issues is crucial in injury prevention and performance enhancement, as these factors can lead to changes in movement patterns and compensatory movements in the closed kinetic chain, ultimately resulting in damage. Many scientific studies support using the motor-functional screen as a reliable tool in assessing injury prevention and as an indicator of potential non-contact traumatic events. Some studies have shown that data obtained from testing physical performance and FMS assessments can be used independently. Still, there is little evidence about their collective effect or their relationship to each other after a structured intervention program.

The utilization and suitability of the FMS continue to be contentious topics, as several studies have indicated that the FMS is an inconsistent screening tool [25-27]. While certain studies have proposed that the FMS may not be a reliable screening tool, others have shown a notable correlation between FMS scores and the incidence of injuries. These findings imply that the FMS can be valuable in forecasting injury susceptibility and implementing preventative strategies to mitigate injury occurrences, particularly among athletes. It is crucial to recognize that the effectiveness of any screening tool could vary based on the studied population and the particular context in which it is applied. Therefore, the decision to utilize the FMS or any other screening tool should be made after a thoughtful evaluation of its strengths and limitations within the specific population and context under consideration [28, 29].

Our study showed a significant contrast in the FMS scores between the injured and non-injured groups. Additionally, we investigated whether there was a correlation between enhanced FMS scores and overall exercise performance. Nevertheless, it is essential to recognize the constraints of the current study, as certain factors could have impacted the outcomes. One potential limitation is the study population, which comprised a convenience sample from a distinct professional sports cohort. A larger sample size, such as one attained by conducting the study at the league level, would offer enhanced statistical power.

## Conclusion

Based on the results from our statistical sample, which revealed a substantial connection between the functional movement screening test and joint function, it can be inferred that the functional movement screening test is a viable, straightforward, and cost-efficient tool that can complement medical and clinical assessments in screening basketball players, including those engaged in three-person basketball. This test has the potential to provide a precise framework for injury prevention to coaches and healthcare practitioners, thereby aiding in averting injuries among athletes.

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**Conflict of Interest:** None declared.

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