Personalized Application and Applied Research of FMS in Injury Prevention among University Basketball Athletes

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Abstract: This study investigates the effectiveness of Functional Movement Screen (FMS) corrective training in preventing sports injuries among university basketball athletes. Twenty-six male basketball majors aged 18 to 22 from a university's physical education college participated in the study. Initially, all participants underwent a baseline FMS assessment. Tailored corrective training programs were then designed according to the athletes' five distinct playing positions and implemented before regular training sessions over an eight-week period. Following the intervention, a post-training FMS evaluation was conducted. The results revealed a statistically significant increase in the average total FMS score by 1.93 points ($p < 0.05$). Notably, scores in previously low-performing tests—such as the hurdle step, shoulder mobility, and active straight leg raise—improved markedly ($p < 0.05$). These findings indicate that FMS corrective training provides a targeted and effective approach to refining movement patterns critical to basketball performance, thereby significantly reducing the risk of injury.

Keywords: University Basketball Athletes; Functional Movement Screen; Sports Injury; Corrective Training; Injury Prevention

1. Introduction

Functional Movement Screen (FMS) is a screening system grounded in fundamental movement patterns, designed to predict injury risk by evaluating seven core movement tasks: deep squat, hurdle step, inline lunge, shoulder mobility, active straight leg raise, trunk stability push-up, and rotary stability [1]. Each of these seven movements is scored on a standardized scale from 0 to 3, with a total possible score of 21. Any occurrence of pain during the assessment results in an automatic zero for that particular test item. This methodology enables the identification of deficiencies and imbalances in flexibility, stability, and movement patterns. Moreover, FMS can detect compensatory movement strategies that athletes adopt, thereby facilitating improved movement efficiency, reducing the likelihood of injury, and ultimately enhancing overall athletic performance. Basketball, as a high-intensity, contact-driven sport, involves frequent physical confrontations throughout the majority of gameplay. In such a demanding environment, athletes must maintain not only completion but also the quality and explosiveness of their movements under intense bodily contact [2]. Within China's fields of sports science, rehabilitation medicine, and athletic training, the application of FMS has steadily expanded. It now broadly encompasses elite sports (for injury risk assessment among high-performance athletes), general fitness (for correction of movement compensations), and sports rehabilitation (to aid functional recovery post-injury). Current domestic research focuses primarily on three dimensions: first, validating the reliability and validity of FMS to establish a scientific foundation for its clinical and training applications; second, investigating its predictive power in different populations to define its risk warning value; and third, evaluating the effectiveness of corrective training based on FMS assessment results to identify effective pathways for functional improvement [3].

In the dynamic context of basketball competition, rapid transitions between offense and defense, diverse tactical movements, and variable opponent defensive and offensive intensity demand [4] that players continuously engage in physical clashes, boxing out for rebounds, lower limb extension during jumps, successive jumps, ball-handling breakthroughs, abrupt stops and starts, as well as pivots and physical contests to execute scoring actions. These movement patterns impose considerable stress on athletes' hip, knee, ankle, and shoulder joints, as well as the posterior chain of the lower limbs. Over time, such repetitive loading can alter athletes' movement patterns, substantially

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increasing the risk of injury on the court. Therefore, the proactive implementation of scientifically grounded FMS corrective training aimed at optimizing athletes' force production and movement patterns plays a vital role in preventing injury, enhancing physical function, maximizing training efficacy, and elevating sport-specific performance among basketball players [5].

Currently, domestic research and application of FMS-based corrective training within university-level basketball programs remain limited. In response, this study intends to administer FMS tests among basketball majors, analyze the impact on their movement patterns and injury risk, and develop targeted corrective training programs informed by these assessments. The subsequent evaluation of FMS-based corrective training outcomes aims to provide valuable references for injury prevention and rehabilitation in university basketball programs [6], thereby establishing a foundation for more scientific and effective training protocols.

2. Research Subjects and Methodology

2.1 Research Subjects

The present study involved 26 male basketball specialization students, aged 18 to 22, from the Physical Education College of a certain university as the experimental cohort.

2.2 Research Methodology

2.2.1 Literature review

A systematic and comprehensive review of pertinent literature was conducted through academic databases such as China National Knowledge Infrastructure (CNKI), Wanfang Data, and Web of Science. Relevant domestic and international scholarly works addressing topics including "Functional Movement Screen (FMS)", "functional training", and "university basketball athletes" were meticulously retrieved and synthesized. This rigorous compilation of the most current research findings and cutting-edge knowledge provided a robust theoretical foundation to support the advancement of this study.

2.2.2 FMS tests and scoring

The Functional Movement Screen (FMS) consists of seven fundamental tests, each designed to assess specific aspects of mobility, stability, and motor control: (1) Overhead Deep Squat: Assesses the flexibility and stability of the shoulders, scapulae, and thoracic spine, as well as the coordinated control between the upper limbs and trunk during the squat movement. (2) Hurdle Step: Assesses the mobility and stability of the hip and knee joints, focusing on the range of motion and the coordinated activation of lower limb muscles during stepping motions. (3) Inline Lunge: Measures both static and dynamic stability of the hip, knee, and ankle joints, reflecting the ability to maintain balance and trunk control while the legs are positioned in a split stance. (4) Shoulder Mobility: Examines the range of motion in shoulder flexion, extension, and abduction, alongside the thoracic spine's capacity for extension. (5) Active Straight Leg Raise: Assesses the mobility of lower limb joints, the flexibility of the posterior muscle chain, and the degree of hip flexion. (6) Trunk Stability Push-Up: Assesses the integrated stability and strength of the core musculature and upper limbs during pushing movements, indicating core stability and force transmission under anterior load. (7) Rotary Stability: Tests the dynamic stability of the core muscles during rotational movements, highlighting the core's role in coordinating arm and leg actions during trunk rotation.

2.2.3 Corrective training program

This study was conducted over an eight-week period from March to May 2025 in the basketball gymnasium, with training sessions held three times per week. Personalized FMS corrective training programs were meticulously designed according to the five distinct on-court playing positions. Intervention training lasted for eight consecutive weeks. At the midpoint of the study (week 4), a reassessment was performed on the basketball specialization students to collect interim data. Any anomalies or special conditions observed were promptly addressed with adjustments to the training protocols. Upon completion of the eight-week intervention [7], a final assessment was conducted, followed by comprehensive data analysis and compilation of the experimental report. The detailed corrective training regimen is outlined in Table 1.

2.2.4 Statistical analysis

Data were analyzed and examined using SPSS 26.0 software to provide a robust basis for this experimental study by comparing FMS scores before and after corrective training. Intergroup

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comparisons utilized independent samples t-tests, with significance set at ($p < 0.05$) (indicating statistically significant differences).

Table 1. Position-Specific FMS Corrective Training Program for Basketball Specialization Students

Position	Corrective training	Specialized Training
Point Guard	Resistance band ankle dorsiflexion dynamic stretches: 15 reps × 4 sets; single-leg jump rope (soft mat): 60 reps × 4 sets; Weighted heel raise Bulgarian split squats: 10 reps × 4 sets	Full-court zigzag dribbling: 3 sets; Fast break with Euro-step finish: 4 sets; Hip-knee-ankle coordinated long passes in fast break reception: 5 sets
Shooting Guard	Single-leg Romanian deadlift for alignment correction: 10 reps × 4 sets; Weighted backward sled pulls: 20 meters × 4 sets; Drop jump landing cushioning: 6 reps × 3 sets; Nordic hamstring curls: 10 reps × 3 sets	Band-resisted jump shots targeting knee stability: 8 reps × 3 sets; Multi-rhythm stop-and-shoot drills: 15 reps × 3 sets; Full-court run-and-catch shooting: 10 reps × 5 sets
Small Forward	Rotational medicine ball tosses: 8 reps × 5 sets; Russian twists: 30 reps × 5 sets; Shoulder musculature release; Single-leg weighted knee raises: 12 reps × 4 sets	Half-court contested layups: 8 reps × 5 sets; Dynamic ball-handling against resistance (soft mat); Full-court fast break layups: 8 reps × 3 sets
Power Forward	Single-leg static squats: 30 seconds × 4 sets; Kneeling rotational push-pulls: 10 reps × 4 sets; Rotational landmine presses: 15 reps × 4 sets; Single-leg glute bridges: 15 reps × 4 sets	Continuous jump stops and board taps with the ball: 12 reps × 3 sets; Multi-directional slides across the court: 4 sets; Half-court contested up-and-under layups: 8 reps × 3 sets
Center	Weighted crawling: 15 meters × 4 sets; Single-leg hops on soft mat: 30 reps × 5 sets; Lateral shoulder wall circles: 20 reps × 4 sets; Rocket push-ups: 8 reps × 4 sets	Consecutive rebound jumps with long passes: 8 reps × 3 sets (core and shoulder strength integration); Pick-and-roll step-through lunges with ball reception: 10 reps × 5 sets (enhancing knee and ankle load capacity); Contested spin hook shots: 8 reps × 4 sets (core stability under contact)

Note: Members of the basketball specialization class may adjust training intensity based on their individual condition.

3. Results and Analysis

3.1 Pre-Intervention FMS Score Distribution

As illustrated by Table 2, participants demonstrated superior performance in the overhead deep squat, inline lunge, trunk stability push-up, and rotary stability assessments. Conversely, average scores for the hurdle step, shoulder mobility, and active straight leg raise tests fell below 2 points. A predominant proportion of score-2 ratings across various tests indicates that most subjects were capable of fundamentally completing the movements, yet compensatory motor patterns persisted. Notably, total FMS scores below 14 are indicative of an elevated risk of sports-related injuries [8]. The overhead deep squat, hurdle step, and inline lunge collectively serve as comprehensive indicators of athletes' hip, knee, and ankle joint stability and mobility, lower limb force transmission efficiency, and accuracy in execution of lower limb power-generating movement patterns. The shoulder mobility test reflects thoracic spine extension and shoulder joint flexibility. The active straight leg raise not only gauges hamstring flexibility but, when evaluated alongside trunk stability push-up and rotary stability, also assesses the strength of core musculature control, anti-rotational capacity, and the synergistic engagement of core and upper limb muscles. The low scoring rates observed in the hurdle step, shoulder mobility, and active straight leg raise tests suggest a heightened susceptibility among the participants to injuries such as hip, knee, and ankle joint traumas, rotator cuff strains, and posterior lower limb muscle chain strains.

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Table 2. FMS Score Distribution Prior to Corrective Training

Indicator	Mean Score	Score 3 Rate	Score 2 Rate	Score 1 Rate	Score 0 Rate
Overhead Deep Squat	2.44±0.47	46.15% (12 athletes)	53.85% (14 athletes)	0.00%	0.00%
Hurdle Step	1.96±0.56	7.69% (2 athletes)	80.77% (21 athletes)	11.54% (3 athletes)	0.00%
Inline Lunge	2.28±0.42	26.92% (7 athletes)	73.08% (19 athletes)	0.00%	0.00%
Shoulder Mobility	1.87±0.68	15.38% (4 athletes)	57.69% (15 athletes)	26.92% (7 athletes)	0.00%
Active Straight Leg Raise	1.94±0.57	7.69% (2 athletes)	76.92% (20 athletes)	15.38% (4 athletes)	0.00%
Trunk Stability Push-Up	2.54±0.47	53.85% (14 athletes)	46.15% (12 athletes)	0.00%	0.00%
Rotary Stability	2.30±0.33	30.77% (8 athletes)	69.23% (18 athletes)	0.00%	0.00%

3.2 Total FMS Score Results Before and After Intervention

As demonstrated in Table 3, prior to the intervention, the basketball specialty class students exhibited a relatively low average total FMS score of 15.33±1.60, indicative of a heightened risk of sports-related injuries and the presence of compensatory motor patterns. Following an eight-week regimen of personalized FMS corrective training, the participants' average total FMS score markedly increased to 17.26±1.41. The post-intervention mean score was significantly elevated compared to the pre-intervention value ($p<0.05$). These findings empirically substantiate that individualized FMS corrective training significantly enhances injury risk mitigation and optimizes movement pattern efficacy among basketball specialty students ($p<0.05$).

Table 3. Total FMS Scores of Basketball Specialty Class Students Before and After Personalized Corrective Training (N=26)

FMS Total Score	Training Group (n=26)
Pre-Intervention	15.33±1.60
Post-Intervention	17.26±1.41*

* indicates a statistically significant difference in FMS scores before and after training ($p<0.05$).

3.3 FMS Individual Item Scores Before and After Intervention

As shown in Table 4, following an eight-week personalized FMS corrective training program, scores across all functional movement assessments exhibited improvement relative to their pre-intervention baselines. Particularly, low-performing items such as the hurdle step, shoulder mobility, and active straight leg raise—presumably compromised by prolonged specialized positional training—showed significant enhancements ($p<0.05$). The overall elevation in scores reflects a comprehensive amelioration of previously deficient items alongside synergistic enhancement of existing strengths. Post-intervention improvements in unilateral lower limb stability, shoulder joint flexibility, hamstring extensibility, and core musculature control collectively demonstrate the high adaptability and precise efficacy of FMS corrective training. This targeted intervention effectively refines basketball specialty students' motor recruitment patterns, mitigates compensatory movement strategies, and reduces the incidence of injuries affecting the hip, knee, and ankle joints, rotator cuff strains, and posterior lower limb muscle chain trauma. Consequently, this approach offers a robust framework for the proactive prevention of sports-related injuries within competitive basketball contexts.

Table 4. FMS Item Scores of Basketball Specialty Class Students Before and After Corrective Training (N=26)

Indicator	Training Group (Pre-Intervention)	Training Group (Post-Intervention)
Overhead Deep Squat	2.44 ± 0.47	2.62 ± 0.44
Hurdle Step	1.96 ± 0.56	2.38 ± 0.47*
Inline Lunge	2.28 ± 0.42	2.48 ± 0.49
Shoulder Mobility	1.87 ± 0.68	2.23 ± 0.71*
Active Straight Leg Raise	1.94 ± 0.57	2.21 ± 0.36*
Trunk Stability Push-Up	2.54 ± 0.47	2.82 ± 0.46
Rotary Stability	2.30 ± 0.33	2.52 ± 0.30

* indicates statistically significant difference between pre- and post-training scores ($p<0.05$).

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4. Discussion

4.1 Analysis of Players' FMS Scores Prior to Intervention

Before the corrective training, students enrolled in the basketball specialty class exhibited varying degrees of deficiencies across all FMS test items. These shortcomings predominantly stemmed from entrenched technical movement patterns and an imbalanced training structure inherent to prolonged competition and practice. Shoulder mobility ranked as the lowest-scoring domain, attributable to unilateral movement habitualization, asymmetrical upper limb strength utilization, and compensatory exertion under resistance conditions [9]. The hurdle step scores were compromised by chronic single-leg load bearing, inadequate stability training, and fatigue-induced movement distortions. Deficiencies in the active straight leg raise correlated with insufficient lower limb flexibility training, suboptimal landing shock absorption, and weakened core stabilizing musculature. Loss of points in the overhead deep squat and inline lunge reflected impaired force line control and bilateral strength imbalances. Minor deficits in trunk stability push-up emerged from scapular instability and diminished core muscle control, while rotary stability was hampered by a lack of anti-rotational training and disrupted coordination between upper and lower limbs. In summary, the long-term entrenchment of specialized movement patterns combined with disproportionate training led to functional impairments in muscle strength, joint mobility, and core control, ultimately causing pervasive deficiencies throughout the FMS battery.

4.2 Impact of Intervention on Players' FMS Scores

After an eight-week regimen of FMS corrective training, the basketball specialty class students demonstrated marked improvements across all assessed FMS items. Notably, the previously lowest-performing items—shoulder mobility, hurdle step, and active straight leg raise—exhibited the most pronounced gains ($p<0.05$). The intervention effectively rectified long-standing limitations stemming from basketball-specific training, including restricted shoulder joint mobility, inadequate single-leg stability, and suboptimal posterior lower limb extensibility, thereby substantially mitigating injury risks associated with rapid directional changes, stoppages, and contested shooting maneuvers. Concurrent enhancements in fundamental movements such as the overhead deep squat, inline lunge, and trunk stability push-up reinforced coordinated multi-joint hip, knee, and ankle force production, unilateral strength symmetry, and core stabilization. Improvements in rotary stability further refined trunk anti-rotational capacity and integrated upper-lower limb force coupling. Collectively, this targeted corrective regimen holistically optimized movement patterns, effectively resolving muscular imbalances and compensatory strategies engendered by specialized training, while laying a solid foundation for enhanced basketball-specific technical execution and injury prevention [10].

In conclusion, the deficiencies identified across the assessed FMS items were substantially ameliorated following the eight-week intervention. Owing to limitations in study duration and sample size, it is recommended that students in the basketball specialty class persistently incorporate these corrective training protocols in subsequent programs to fortify vulnerable musculature and ligamentous structures, thus averting sports injuries precipitated by movement compensation or muscular insufficiency during athletic performance.

5. Conclusion

Following the implementation of individualized FMS corrective training, the average total FMS score significantly increased from 15.33 ± 1.60 to 17.26 ± 1.41 ($p<0.05$). Marked improvements were observed in previously low-scoring items such as the hurdle step, shoulder mobility, and active straight leg raise ($p<0.05$). These findings underscore the precise, targeted efficacy of FMS corrective training in rectifying compensatory movement patterns and muscular imbalances, thereby substantially mitigating the risk of sports-related injuries. Consequently, the integration of FMS corrective protocols within collegiate basketball specialty training regimens is affirmed as valuable, scientifically sound, and practically feasible.

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