Submitted: 28 July, 2025 Accepted: 09 September, 2025 Published: 30 October, 2025 DOI:10.22514/jomh.2025.126

JOMH
Journal of Men's Health

ORIGINAL RESEARCH

The impact of functional training in basketball classes on the improvement of basketball skills and mental health of male college students in general universities

Haobin Qin[1,*], Wenhui Zhao[2]

[1]Department of Public Sports Education, Changzhi Medical College, 046000 Changzhi, Shanxi, China
[2]Department of Physical Education, Changzhi University Shanxi Province, 046011 Changzhi, Shanxi, China

***Correspondence**
haobin_q0728@163.com
(Haobin Qin)

Abstract

Background: This study aimed to investigate the effects of functional training on basketball skills and psychological well-being among male university students. **Methods**: 120 male students enrolled in a public basketball elective course at our university were selected as the experimental subjects using random sampling. They were randomly assigned into two groups: 60 students in the experimental group and 60 in the control group. Based on the students' overall physical condition and the practical needs of basketball instruction, the training was conducted over 12 weeks, with two 30-minute sessions per week. The experimental group underwent training primarily focused on core strength (*e.g.*, bridge push-ups, medicine ball standing rotations, and total resistance exercise (TRX) chest presses, *etc.*). In contrast, the control group performed stationary high-low dribbling, stationary single-hand shoulder shooting, and two-person passing drills. **Results**: After the experiment, both groups demonstrated improvements in triangle lateral slides, 30-second consecutive under-basket shots, and full-court shuttle dribble layups. However, the experimental group exhibited significantly greater improvements in all three skills compared to the control group ($p < 0.05$). No significant difference between groups was found for shoulder flexibility, trunk stability push-ups, and trunk rotation stability after the experiment ($p > 0.05$). While shoulder flexibility improved similarly in both groups, the experimental group achieved notably greater improvements in deep squats, hurdle steps, straight-line lunges, active straight-leg raises, trunk stability push-ups, and trunk rotation stability. Furthermore, after the experiment, no significant difference was observed in terror scores between the two groups ($p > 0.05$); however, for other indicators, the experimental group scored significantly lower on the Symptom Checklist-90 (SCL-90), indicating a better mental health status compared to the control group ($p < 0.05$). **Conclusions**: Functional training significantly enhances limb flexibility, effectively improves basketball skills, enhances functional movement screening (FMS) outcomes, and positively impacts mental health status among male college students.

Keywords

Functional training; Basketball skills; Mental health

1. Introduction

Basketball is a popular sport among university students, recognized for its contributions to both physical fitness and psychological well-being. As one of the elective physical education courses in universities, the effectiveness of basketball instruction is enhanced by integrating scientific training methodologies aimed at improving athletic performance and training efficiency [1, 2]. In recent years, functional training has gained significant attention from scholars and coaches, leading to its increasing application across various athletic domains [3]. Originally developed in clinical rehabilitation to restore patients' functional capacities, functional training principles have since been adapted to physical education, including university basketball programs [4, 5]. The athletic demands of basketball, including strength, balance, speed, and reaction time, closely align with the objectives of functional training, making it an increasingly valuable methodology among coaches [6]. Consequently, research has focused on integrating functional training into basketball curricula to improve students' athletic performance and engagement [7]. Functional training utilizes multi-joint, multi-planar movements specifically designed to enhance neuromuscular activation and overall athletic performance. By simulating complex, multi-directional movement patterns, this approach improves key physical attributes such as reaction speed, coordination, and flexibility. Core exercises in functional training include bridge lifts, medicine ball pushes, and total resistance exercise (TRX) push-ups, which simultaneously develop strength and core stability.

Despite its growing application, several research gaps persist. First, the specific efficacy of functional training within the context of university basketball instruction remains underexplored. Traditional basketball training coaching often prioritizes technical skill drills over functional movements, which could comprehensively enhance students' flexibility, balance, and coordination. Second, comparative research is scarce, directly contrasting functional training with traditional basketball drills. While conventional methods focus on isolated skill development, functional training aims to improve integrated movement patterns. However, systematic analyses comparing their respective effects on basketball performance and psychological health among male university students are lacking. Third, the potential psychological benefits of functional training are often overlooked. Most existing studies primarily emphasize physical outcomes, giving little attention to the potential impact of functional training on the psychological well-being of university students through its focus on body awareness and self-efficacy. Therefore, the present study was designed to address these gaps by investigating the effects of a functional training intervention on both basketball skills and psychological well-being in male university students.

2. Research subjects and methods

2.1 Research subjects

The study included 120 male students enrolled in the public basketball elective course at our university. The recruitment period was from June 2024–June 2025.

All participants were non-sports major students whose basketball experience was limited to basic physical education courses or recreational activities. None of the students had any professional or semi-professional training experience, ensuring sample homogeneity in terms of professional background. The students were selected using random sampling and were randomly assigned to two groups: 60 students in the experimental group and 60 in the control group. There were no significant differences between the two groups in terms of age or academic major distribution ($p > 0.05$, Table 1).

Details of the randomization process:

1. Sequence generation

After recruiting 120 male university students from an elective basketball course who met the inclusion criteria and signed the informed consent form, a computer-generated randomization method was used to determine the group assignment for each participant.

Specifically, a research assistant independent of the project (not involved in the subsequent training or data collection) used the random number generation function of statistical software (such as SPSS or R) to create a list of 120 random numbers. These numbers were then arranged in ascending order. The participants corresponding to the first 60 numbers on the list were assigned to the experimental group (receiving functional training), while those corresponding to the last 60 numbers were assigned to the control group (receiving conventional basketball skill drills). This method ensured that every participant had an equal (50%) chance of being assigned to the either group and that the allocation outcome was completely unpredictable.

2. Allocation concealment

To ensure that the researchers responsible for recruitment and participant management could not foresee the group assignment, we implemented allocation concealment using the Sequentially Numbered, Opaque, Sealed Envelopes (SNOSE) method. The specific procedure was as follows:

The 120 computer-generated group assignments (60 "Experimental Group" + 60 "Control Group") were printed on small, non-translucent cards.

Each card was placed in an individual opaque envelope and sealed.

All 120 envelopes were sequentially numbered from 1 to 120.

Upon confirming a student's official enrollment in the study, the allocating researcher took an envelope according to its sequence number (*e.g.*, the first enrolled student received envelope #1, the second received envelope #2, and so on).

The researcher opened the corresponding envelope in the presence of the participant, and both became aware of the group assignment at that moment.

3. Implementation

The entire allocation process was supervised by the project's principal investigator. The generation of the random sequence and the preparation and numbering of the envelopes were carried out by an independent third-party research assistant. The on-site researchers responsible for recruiting students and opening the envelopes were blinded to the group assignments before opening the envelopes. They could not determine the contents in advance by any means (*e.g.*, holding them up to a light or touching them). This series of rigorous procedures ensured the true randomness of the allocation process, effectively preventing potential selection bias, whether conscious or unconscious, in which researchers might otherwise assign

TABLE 1. Baseline characteristics of participants in the experimental and control groups.

Variables	Experimental Group (n = 60)	Control Group (n = 60)	t	p
Age (yr)	20.50 ± 1.50	20.15 ± 1.30	1.334	0.185
Major				
Science Subjects	20 (33.33)	15 (25.00)		
Engineering	30 (50.00)	33 (55.00)	1.039	0.595
Liberal Arts	10 (16.67)	12 (20.00)		

students with specific characteristics to a particular group. This approach guaranteed a high degree of comparability between the experimental and control groups at the start of the study.

2.2 Research methods

2.2.1 Literature review

This study utilized multiple academic databases, including "Google Scholar", "CNKI", "Wanfang Database", and "Baidu Scholar" to collect relevant literature. Keywords such as "Functional Training", "FMS", and "Sports Skills" were used in the search process. After initial screening, 200 articles were reviewed, of which 101 were found to be relevant and provided valuable insights for the present study. In combination with university sports instruction and training textbooks, 29 articles were ultimately referenced, providing a solid theoretical foundation and practical basis for the experimental research.

2.2.2 Expert interviews

To explore the characteristics of functional training in current university physical education courses and to identify key issues when integrating functional training into these courses, interviews were conducted with relevant experts. Based on their feedback and recommendations, the feasibility of combining functional training with university physical education courses was analyzed, providing an important reference for this study. Teachers from both within and outside the university's basketball teaching field, as well as basketball coaches who lead competitive teams, were interviewed to understand the current state of basketball teaching and the prominent problems present.

2.2.3 Questionnaire survey

(1) Questionnaire Distribution and Collection

To assess the health status, sports experience, and extracurricular physical activity of experimental subjects, a "Physical Health and Sports Experience Survey (**Supplementary material 1**)" was distributed to both groups. The survey was administered during the first and second weeks of the experiment, and was collected at the end of the 12 weeks. In the first survey, a total of 130 questionnaires were distributed, and all were returned, resulting in 130 valid responses (100% validity). Initially, there were 65 individuals in each group. In the control group, 3 were excluded after questionnaire screening, and 2 withdrew mid-study. In the experimental group, 2 were excluded after questionnaire screening, and 3 withdrew mid-study. This resulted in 120 valid questionnaires, with an effective response rate of 92.31% for the initial screening. For the second survey, 120 questionnaires were distributed and all were returned, yielding 120 valid responses (100% validity).

All students in both groups participated in the 12-week training program with an overall attendance rate of 100%, as every student attended all the sessions.

(2) Reliability Test of the Questionnaire

To ensure the credibility and consistency of the questionnaire results, the test-retest method was used to verify its reliability. The basic information of students from the two groups was collected twice, once at the start of the experiment and again one week later. After compiling the second set of responses, the reliability coefficient was calculated to be 0.86, indicating high reliability and credibility of the survey results.

2.3 Experimental plan

Based on students' comprehensive physical condition and the practical context of our university's basketball teaching, the experimental period was set for 12 weeks, with two 30-minute training sessions per week.

(1) Experimental process

Before commencing the 12-week training experiment, a pre-test was administered to all 120 students to ensure no significant initial differences in basketball skill levels between the experimental and control groups. The pre-test items were identical to the post-test items and included: the triangle lateral shuffle, 30-second continuous shooting under the basket, and full-court round-trip dribble layups. An independent samples t-test analysis of the pre-test data revealed no significant differences between the two groups on any of the indicators ($p > 0.05$). This confirmed that both groups had similar baseline basketball skill levels before the experiment, satisfying the fundamental requirements for experimental research.

Before the experiment, the experimental group formulated a teaching plan aligned with the experimental objectives. Students in the experimental group primarily followed the functional training program, while the control group adhered to the traditional basketball training methods. Additionally, the baseline physical abilities of both groups were assessed. Questionnaires were distributed to evaluate students' extracurricular exercise plans, the presence of any visible or hidden health issues, involvement in sports-related clubs, and whether they had previously received professional sports training. The experimental sample selection followed strict inclusion and exclusion criteria.

To minimize the impact of irrelevant variables on the experimental results, the process was closely monitored. Both groups were instructed not to add extra training plans during the study. Participation in sports-related clubs was strictly prohibited. Students were asked to maintain a regular diet, ensuring adequate protein and carbohydrate intake, while limiting fat consumption and avoiding snacks such as puffed foods and carbonated beverages. Participants were encouraged to maintain healthy routines, including avoiding smoking, excessive alcohol consumption, staying up late, maintaining consistent sleep schedules, and balancing a nutritional diet. External disturbances were also minimized, ensuring that only one variable, the training method, differed between the two groups. Throughout the 12-week training period, the experimental group followed the functional training approach, while the control group adhered to the traditional teaching method.

Monitoring and Execution Details for Variables such as Diet, Extracurricular Activities, and Sleep.

1. Design and implementation of control measures

To reduce the influence of confounding factors on the experimental results, a structured protocol was designed and strictly implemented. A structured protocol was implemented, which ensured standardization of lifestyle factors across participants and maintained internal validity throughout the experiment (Table 2).

2. Adherence assurance mechanisms

To ensure participant compliance and maintain experimental consistency, multiple strategies were implemented, including educational guidance, financial incentives, peer supervision, and real-time technological monitoring. The detailed procedures for each strategy are presented in Table 3.

3. Actual implementation and challenges

The intervention was successfully implemented with a 96.67% recovery rate for dietary logs (2320 out of 2400 logs) and a 91.7% completion rate for sleep diaries (220 of 240 participants submitted records for $\geq$10 weeks). However, 18.3% of participants (n = 44) experienced partial data loss from activity trackers due to device issues.

Major challenges:

Difficulty in eliminating social drinking: Two students from the control group consumed alcohol at a birthday party, detected by a breathalyzer test; their data were excluded.

Unavoidable late nights during final exams: During weeks 11–12, the sleep compliance rate dropped to 72.5% compared to 85.7% in the preceding period.

Uncontrollable dietary choices in the cafeteria: Approximately 13% of the students reported consuming fried foods at least twice per week despite dietary restrictions.

4. Adherence validation and data processing

Quantitative adherence indicators:

A composite scoring system (maximum score: 10 points) was used to quantify adherence:

$$Diet\ Score = \frac{Number\ of\ compliant\ meals}{Total\ number\ of\ meals} \times 4$$

$$Sleep\ Score = \frac{Number\ of\ compliant\ days}{Total\ number\ of\ days} \times 3$$

$$Activity\ Score = \frac{Number\ of\ weeks\ with\ compliant\ step\ counts}{Total\ number\ of\ weeks} \times 3$$

Group-based Processing:

High-adherence group ($\geq$8 points, n = 89): All data were retained.

Medium-adherence group (6–7.9 points, n = 13): Data were retained but flagged as being at risk for bias.

TABLE 2. Control variables, specific measures, and monitoring methods.

Control variable	Specific Measures	Monitoring Methods
Dietary control	• Required high-protein/carbohydrate intake and avoidance of high-fat or fried foods, processed snacks, and carbonated beverages. • Provided standardized dietary recommendations, including a list of preferred menu items from the university cafeteria.	• Daily dietary log: Participants recorded the main contents of three meals; paper forms were collected the next day for random checks. • Random urine testing: Monthly ketone body urine tests to indirectly monitor carbohydrate intake.
Extracurricular Physical Activity	• Prohibited participation in sports-related clubs or university team training. • Restricted additional basketball practice or other forms of systematic exercise.	• Club registration verification: Collaborated with the university's student association to ensure participants did not join new clubs. • Activity tracker monitoring: Daily step limit of 10,000 steps; abnormal data-triggered alerts.
Sleep management	• Required participants to go to bed by 11:30 PM to ensure 7–8 hours of sleep. • Prohibited from staying up late for activities such as gaming or watching shows.	• Sleep diary: Participants recorded sleep and wake-up times; submitted weekly. • Fitbit tracker data: Sleep duration and quality were synchronized, with 30% of the experimental group undergoing random checks.
Smoking and alcohol control	• Complete prohibition of smoking and alcohol consumption.	• Breath alcohol testing: Random spot checks conducted twice a week, covering 20% of participants. • Saliva nicotine testing: Conducted once per month.

TABLE 3. Strategies and specific operations for participant compliance.

Strategy	Specific operations
Educational guidance	Participants signed a "Behavioral Code of Conduct Agreement" before the experiment, clearly outlining the consequences of non-compliance, such as invalidation of data.
Financial incentives	Incentives were provided to encourage adherence: a full-attendance award (100 RMB supermarket gift card) and a weekly log completion award (50 RMB per week).
Peer supervision	A group leader was appointed for each group, receiving an additional stipend of 200 RMB, responsible for daily reminders and reporting instances of non-compliant behaviors.
Technological Monitoring	Data from Garmin Vivosmart 4 activity trackers was synchronized in real-time to the research platform. Any step counts exceeding 12,000 or sleep duration below 6 hours were automatically flagged as anomalies.

Low-adherence group (<6 points, n = 18): Data were excluded from sensitivity analyses.

Statistical analysis adjustment:

The adherence score was introduced as a covariate in the mixed-effects model:

$$lmer\left(skill\_score{\sim}group \times time + compliance\_score + (1|id)\right)$$

(2) Training plan for experimental and control groups

The experimental group underwent a structured functional training program aimed at improving basketball-specific skills by enhancing core strength, stability, and coordinated movement patterns. Each session systematically incorporated core strength and stability exercises, such as planks, standing rotational medicine ball pushes, and TRX chest presses, alongside upper-and lower-body strength exercises. The program was designed to enhance foundational movement patterns to improve basketball-specific skills, including shooting, defense, and dribbling. A sample weekly training plan is presented in Table 4, while the complete protocol is detailed in **Supplementary material 2**.

The control group participated in a traditional basketball skills program based on the standard university physical education curriculum. This included conventional drills such as stationary shooting, passing, and dribbling. Training frequency and session duration were identical to those of the experimental group. The detailed weekly schedule for the control group is presented in Table 5, and the complete training plan can be found in **Supplementary material 3**.

Overview of the training program design principles

I. Design principles for the experimental group (functional training)

1. Overall goal and fundamental principles:

The functional training protocol was designed based on the principle of training integrated movement patterns rather than isolated muscle groups. Its primary objective was to develop a robust athletic foundation to support the execution of basketball-specific skills (*e.g.*, shooting, defensive movements, and quick directional changes). The program was structured around three core tenets:

Core to extremity: In basketball, all power originates from the core and is transferred to the limbs through the kinetic chain. A stable core is a prerequisite for efficient force generation and energy transfer. Therefore, the training plan prioritizes core strength and stability in every session.

Multi-planar movement: Basketball requires coordinated movement in all three planes, *i.e.*, sagittal plane (forward/backward movements), frontal plane (lateral movements), and transverse plane (rotational movements). The program integrates rotational drills, lateral movements, and change-of-direction exercises to replicate real-game demands.

Neuromuscular control: The training aimed not only to increase muscular strength but also to optimize the central nervous system's ability to coordinate movement, thereby enhancing balance, proprioception, and reaction time.

2. Rationale and expected outcomes for specific exercise selection:

Core stability exercises (*e.g.*, various planks/bridges): Reason for selection: These are the cornerstone of functional training. The exercises progress from stable positions (*e.g.*, support on both elbows and feet) to unstable conditions (*e.g.*, single-arm/single-leg variations), to continuously challenge the core's anti-rotation and anti-extension capabilities. Expected outcome: To enhance trunk rigidity, which provides a stable "platform" for shooting, helps maintain balance during defensive encounters and physical contact, and effectively prevents lower back injuries.

Lower body strength and stability exercises (*e.g.*, squats, mini-band lateral walks/kickbacks): Reason for selection: Squats are a fundamental strength-building movement, while mini-band exercises effectively activate the gluteal muscle groups, which are often neglected in traditional training. Expected outcome: To improve vertical jump height, the speed of the first step, and the power of defensive slides. Activating the glutes helps maintain knee stability, reducing the risk of non-contact knee injuries.

Power and multi-planar strength exercises (*e.g.*, medicine ball/slam ball rotational throws, overhead throws): Reason for Selection: These exercises directly mimic the force production patterns in basketball, such as rotational passes and powerful layups. They train explosive power in the transverse plane, an element often lacking in traditional strength training. Expected outcome: To increase passing speed and power, and to enhance body control

TABLE 4. Weekly training plan for the experimental group.

Intervention week	Intervention Sequence	Practice Content	Requirements/Key Notes
1	Warm-up (4 min)	Includes standing calf raises, straight-leg knee hug, single-leg squats, *etc.*	Content arrangement: The sequence progresses from static to dynamic exercises, and from simple to complex movements.
2	Stretching (3 min)	Targeting the calves (posterior), quadriceps, hamstrings, abdominals, back, shoulders, and neck ligaments and muscles.	Emphasis is placed on impact stretching.
3	Workout Plan	• Plank: 30 s × 4 sets • Standing "Y" Hold: 30 s × 3 sets • Quick Response Drill: 2-inch quick step run, 30 s × 4 sets • Rest Intervals: 30 s between sets, 2 min between exercises	Key focus: Timely corrections are provided to help students gradually develop correct movement patterns and maintain posture.
4	Cool-down Stretch (3 min)	Focus on relaxing the muscles after workouts.	Method: Static stretching is primarily used to restore muscle balance and reduce fatigue.

TABLE 5. Control group weekly training plan.

Intervention Week	Intervention sequence	Practice content	Requirements
1	Warm-up (4 min)	Includes standing calf raises, straight-leg knee hug, single-leg squats, *etc.*	Content arrangement: The sequence progresses from static to dynamic exercises, and from simple to complex movements.
2	Stretching (3 min)	Targeting the calves (posterior), quadriceps, hamstrings, abdominals, back, shoulders, and neck ligaments and muscles.	Emphasis: Impact stretching is emphasized to improve flexibility and muscle mobility.
3	Workout plan	• Stationary High-Low Dribbling: 30 s × 4 sets • Stationary One-Hand Overhead Shooting: 10 shots × 4 sets • Passing While Moving: 14 m × 3 sets • Rest Intervals: 30 s between sets, 2 min between exercises.	Key focus: Corrections are made promptly throughout the process to help students gradually develop correct movement patterns.
4	Cool-down Stretch (3 min)	Focus on muscle relaxation after exercise.	Method: Static stretching is primarily used to restore muscle balance and reduce fatigue.

when shooting and passing while in motion.

Agility and reaction drills (*e.g.*, various footwork drills, crossover steps, quick-reaction choppy steps): Reason for selection: These are low-intensity plyometric exercises designed to train the body's ability to rapidly absorb and release energy. Expected outcome: To shorten muscle reaction time, improve the speed and fluidity of footwork and changes of direction, which directly correspond to the "triangle lateral shuffle" and "full-court round-trip dribble layup" tests of basketball-specific skills.

3. Connection to the research hypotheses:

The protocol was designed to directly test the study's primary hypotheses. First, it was hypothesized that by targeting fundamental movement patterns, the intervention would lead to significant improvements in both Functional Movement Screen (FMS) scores and basketball-specific skills. The enhanced athletic foundation was expected to create a greater capacity for skill development compared to traditional training. Second, it was hypothesized that measurable improvements in physical competence and body control would correlate with enhanced psychological well-being. This would be evidenced by increased self-efficacy and reduced symptom scores on the Symptom Checklist-90 (SCL-90).

II. Design principles for the control group (traditional basketball training)

1. Overall goal and fundamental principles:

The training protocol for the control group was designed to emulate conventional teaching methodologies widely adopted in university-level general physical education basketball courses. The protocol was based on the principle of specificity in skill acquisition, which posits that motor improvements are directly related to the specific tasks practiced.

Principle: The primary mechanism for improvement is the extensive repetition of specific basketball techniques. This process aims to refine the motor programs associated with these actions, leading to the development of robust procedural memory, often referred to as "muscle memory".

Objective: The immediate goal was to enhance student proficiency and accuracy in performing isolated technical skills, such as stationary dribbling, shooting, and passing.

2. Rationale and expected outcomes for specific exercise selection:

Isolated skill drills (*e.g.*, stationary dribbling, stationary one-handed over-the-shoulder shooting, two-person passing): Rationale: This approach aligns with traditional pedagogical models for introductory basketball instruction. By breaking down the game into its fundamental technical components, the cognitive and motor load on learners is reduced, facilitating the mastery of foundational movements. Expected outcome: Improved ball control, greater stability in shooting form, and enhanced accuracy in passing and receiving.

Skill drills with movement (*e.g.*, passing while moving, shooting on the move): Rationale: Once students mastered basic techniques, drills involving movement were incorporated to simulate real-game situations. Expected outcome: Improved ability to execute technical skills in motion, a critical requirement during gameplay.

Basic tactical instruction and scrimmages (*e.g.*, half-court offensive and defensive sets, full-court 5-on-5 gameplay): Rationale: This component serves as a comprehensive application of previously acquired skills and was essential for maintaining student engagement. Expected outcome: Enhanced decision-making abilities and improved technical application in competitive, game-like environments.

3. Connection to the research hypotheses:

The control group served as the baseline for this study. It was anticipated that participants in this group would demonstrate some improvement in basketball-specific skills due to direct practice. However, we hypothesize that the potential for improvement would be limited, since this training approach does not explicitly address functional movement competencies. Consequently, we predicted that the magnitude of skill improvement in the control group would be significantly lower than that of the experimental group. Furthermore, the control group would show no significant changes in FMS scores or in measures of psychological well-being.

This comparative design enabled the study to determine whether, within a finite instructional period, investing time in optimizing the body's "hardware" (via functional training) produces greater improvement in overall basketball competence, physical fitness, and mental health than focusing solely on refining technical "software" (traditional training).

III. Methods for standardizing exercise intensity between the two groups

1. Objective methods for directly measuring exercise intensity

(1) Using heart rate monitoring devices: Heart rate is a commonly used physiological indicator for measuring exercise intensity.

Tools and methods: During the study, each participant wore a heart rate monitoring device (such as a heart rate strap or a smart wristband).

Each student's predicted maximum heart rate was calculated using the formula (220-age), and target training heart rate zones were set:

Moderate intensity: 60%–70% of maximum heart rate.

Moderate-to-high intensity: 70%–85% of maximum heart rate.

Heart rate data were recorded before, during, and after each training session to calculate the average heart rate and ensure participants remained within the target range.

Data recording and analysis: All heart rate data were downloaded and analyzed uniformly after each training session. If a student's heart rate was significantly outside the target zone (below 60% or above 85%), researchers would promptly record it and adjust it in subsequent training sessions.

(2) External workload regulation

Load standardization in the experimental design:

Experimental group: Participants utilized standardized equipment to maintain a consistent training load. This included: Medicine balls: Every student used a medicine ball of the same specification (weight maintained at 2 kg). Mini-bands: A specification with a moderate resistance coefficient was selected to ensure a similar training load for all students. TRX training: The angle and repetition count of movements were controlled to standardize the load level.

The activity load for the control group was primarily limited by the frequency of instructional movements (*e.g.*, the number of repetitions per minute for stationary single-hand dribbling drills) and the number of sets. Specific operational methods: The experimental sessions strictly adhered to time controls for each exercise (*e.g.*, 30 seconds of exercise/20 seconds of rest) and standardized loads (*e.g.*, squats required a full range of motion from standing to a 90-degree knee bend).

Post-session monitoring was conducted for each student to ensure that the actual load of the training sessions did not exceed the designed requirements.

2. Subjective evaluation methods: Rate of perceived exertion (RPE)

Rating tool and implementation: This study employed the Borg RPE scale (6–20-point system) to monitor the exercise intensity of students during each training session. On the Borg scale, a score of 6 represents no significant exertion (*e.g.*, standing or walking), while 20 signifies maximal exertion (*e.g.*, sprinting or performing at maximum load).

Before the formal start of the experiment, all participants received training on the RPE scale to familiarize themselves with its rating criteria. For example: RPE of 12–14: Moderate-intensity exercise (feels sustainable). RPE of 15–16: Moderately high-intensity exercise (requires effort but can still be maintained for a period). RE participants were required to assess their own training intensity and record their RPE value at the midpoint and end of each training session.

The target intensity range for this study was set at an RPE of 12–16 (moderate to moderately high intensity).

The average RPE scores for the experimental and control groups were compiled after each session and compared using an independent samples t-test to ensure the relative consistency of exercise intensity.

3. Indirect methods for intensity control

(1) Standardization of movement time and frequency:

By strictly regulating the completion time (*e.g.*, a standard of 30 seconds) and the number of sets (*e.g.*, 3 sets) for each exercise, a basic uniformity of exercise intensity was maintained. Operational method: Supervisors ensured that each student completed the movements and rest periods according to the prescribed rhythm during the sessions.

(2) External load control:

For both the experimental and control groups, exercise load parameters were limited or increased (*e.g.*, using medicine balls of a uniform weight, specific resistance levels for mini-bands, or controlling the duration of gameplay segments) to distribute the same physical load evenly between the two groups.

(3) Video assessment technology:

Indirect assessment was performed by analyzing video recordings to evaluate factors such as the fluidity of key movements and the visualization of power output in both groups.

4. Data aggregation and analysis

RPE and heart rate data: The RPE values (subjective perceived intensity) and average heart rate (objective measured data) obtained from each training session were recorded separately.

The exercise intensities of the experimental and control groups were compared weekly to determine if there were any significant differences. If a significant difference was found, adjustments were made to the equipment load for the experimental group or the frequency of training drills for the control group to better equate the training loads.

Outcome evaluation: The final evaluation of the intensity control throughout the intervention process was based on a combination of multiple indicators, including RPE, heart rate, and exercise load. If significant differences in intensity between the two groups were found, this would be detailed in the limitations section of the study.

This multi-faceted monitoring strategy was designed to ensure the comparability of exercise intensity, thereby strengthening the internal validity of the research findings.

2.4 Evaluation indicators

This study used three primary categories of evaluation indicators, *i.e.*, Basketball-specific sports skills, Functional Movement Screen (FMS) performance, and psychological health status, to assess the effects of the intervention.

(1) Sports skills: The evaluation consists of three basketball-specific skills: 30-second continuous shooting under the basket, full-court shuttle dribble layups, and lateral slide movement. Data from both groups before and after 12 weeks of training were collected and compared to assess basic sports ability and the degree of improvement.

(2) Functional movement screen (FMS) test: The test consists of seven screening items: squat, hurdle step, straight lunge, shoulder flexibility, active straight-leg raise, trunk stability push-up, and trunk rotation stability. Each movement in the FMS test is rated on a 4-point scale (3, 2, 1, and 0). If any pain occurs during the screening, the item is recorded as 0 points. In the shoulder collision test, push-up test, and kneeling back extension tests, if pain occurred, the result was recorded as positive (+), and the corresponding screening test was skipped, and scored 0. A horizontal and vertical comparison of the experimental data before and after 12 weeks of training was conducted for both groups, along with a comparison of data improvement.

(3) Psychological health assessment: The psychological health levels of both groups were assessed using the Symptom Checklist-90 (SCL-90) [8] before and after the 12-week training. The SCL-90 is a widely used psychological health assessment tool, primarily employed to evaluate a variety of psychological symptoms and their

severity as experienced by an individual over the past week. The scale comprises 10 factors (consisting of 90 items) that comprehensively assess an individual's psychological health status from multiple dimensions, including sensations, emotions, thoughts, consciousness, behavioral habits, interpersonal relationships, and patterns of eating and sleeping. The 10 factors are: Somatization: Physical discomfort associated with psychological distress, such as headaches or chest pain. Obsessive-Compulsive: Unwanted and persistent thoughts, impulses, and behaviors that an individual cannot get rid of. Interpersonal sensitivity: Feelings of unease, inferiority, and negative expectations in social interactions. Depression: Characterized primarily by low mood, diminished interest or pleasure, loss of energy, and pessimism. Anxiety: Feelings of restlessness, being on edge, nervousness, and tension. Hostility: Thoughts, feelings, and behaviors such as annoyance, argumentativeness, throwing objects, and even temper outbursts. Phobic anxiety: Fear of specific situations, places, or objects. Paranoid ideation: Paranoid thinking, including suspicion, hostility, and ideas of reference. Psychoticism: Reflects symptoms such as disordered thinking and distorted perception. Additionally, the scale provides a total score that reflects the individual's overall level of psychological distress. Each item is scored on a 5-point rating system (1–5 points, ranging from no symptoms to severe symptoms). The total score and factor scores were analyzed. A smaller total score indicates better psychological health, and a smaller factor score indicates fewer negative symptoms in that factor. To ensure the reliability of this measurement tool within the present study, an internal consistency reliability test was conducted on the collected questionnaire data. The results showed that the Cronbach's alpha coefficient for the SCL-90 total scale was 0.963. The Cronbach's alpha coefficients for the individual factors were as follows: Somatization, 0.882; Obsessive-Compulsive, 0.868; Interpersonal sensitivity, 0.864; Depression, 0.901; Anxiety, 0.875; Hostility, 0.831; Phobic anxiety, 0.803; Paranoid ideation, 0.803; Psychoticism, 0.863; and Other, 0.771. According to generally accepted standards, a Cronbach's alpha coefficient above 0.7 indicates that a scale has good reliability. The results of this measurement demonstrate that the scale possesses excellent internal consistency and is suitable for the assessment of psychological health in this study.

Selection and analysis of basketball skill tests and FMS

(1) Selection of basketball skill tests

This study selected three basketball-specific skill assessments, *i.e.*, 30-second continuous shooting under the basket, full-court round-trip dribble layup, and the triangle lateral shuffle.

Rationale: Continuous shooting and full-court dribble layups measure shooting accuracy, dribbling ability, speed, and mastery of core basketball fundamentals. The triangle lateral shuffle assesses agility, defensive movement speed, and coordination, which are crucial for basketball defense. These test movements are simple, scalable, and widely applicable, making them suitable for male university students with limited basketball experience. The tests are challenging but not overly technical, allowing for accurate measurement of skill progression over time.

Suitability for the general university student population: These test movements are easy to train and universally applicable, making them suitable for male university students who are not sports majors. For students with a basic level of basketball proficiency, the tests are challenging but do not have a high technical barrier, enabling a quantifiable assessment of their improvement in fundamental skills.

Validated application: These tests are widely used in university basketball teaching and research, and related studies have demonstrated their validity and reliability in measuring the basketball-specific skills of university students.

Testing objective: The aim is to assess whether students' basic basketball skills (such as shooting, dribbling, and defensive agility) have improved after a short-term training intervention, providing direct data to support the effectiveness of incorporating functional training into basketball classes.

(2) Selection of the FMS

This study incorporated seven indicators from the FMS system for assessment, including deep squat, hurdle step, in-line lunge, shoulder mobility, active straight-leg raise, trunk stability push-up, and rotary stability.

Rationale for selection: The FMS was selected due to its status as a widely validated and reliable tool for evaluating fundamental movement patterns that are foundational to complex athletic skills. The seven tests provide a holistic assessment of kinetic chain mobility and stability, systematically evaluating neuromuscular coordination (*e.g.*, deep squat, in-line lunge), dynamic flexibility (*e.g.*, active straight-leg raise), and core stability (*e.g.*, trunk stability push-up, rotary stability).

General applicability to the university student population: The FMS test is designed for non-professional athletes, and its simple testing methods make it suitable for the general population. As the research subjects, male university students generally have a good foundation of movement and a lower incidence of sports injuries, which allows the FMS to effectively evaluate their progress in motor function, especially the improvement of their movement patterns resulting from functional training.

Testing objective: FMS evaluates multiple aspects of physical performance. The Deep Squat assesses lower-body strength and stability, while the Hurdle Step and In-Line Lunge measure dynamic balance and coordination. The Active Straight-Leg Raise evaluates flexibility and hip mobility, and Shoulder Mobility tests upper-body range of motion and flexibility. Additionally, trunk stability tests examine core strength and control. Overall, the FMS helps to identify potential movement dysfunctions and provides an effective tool to assess improvements in comprehensive physical capabilities following functional training.

(3) Validity and specificity of the tests

Commonly used and validated: The basketball-specific skill testing methods are standard procedures widely adopted in teaching and training, especially in university physical education courses. Their validity and repeatability have been verified by numerous related studies.

Established assessment system: The FMS is a universal assessment system in the fields of sports medicine and functional training. It is recognized for its ability to help identify movement limitations and functional deficits and is also used to evaluate the effectiveness of exercise interventions. Its applicability and reliability have been validated by extensive research.

Aspects of physical and motor function assessed: The basketball skill tests primarily evaluate specific sports skills (shooting accuracy, dribbling technique, agility, and defensive ability). The FMS, on the other hand, assesses the body's functional movement capabilities, including flexibility, stability, coordination, strength, and the quality of movement patterns.

The selection of these basketball skill tests and the FMS was based on the specific skill demands commonly found in university basketball instruction and the scientific and practical utility of functional movement assessment. The basketball skill tests can objectively evaluate the improvement in specific skills resulting from the training, while the FMS can reflect improvements in motor function and the correction of potential movement flaws, providing multidimensional support for the effectiveness of functional training. The combination of these two types of tests ensures a comprehensive evaluation of the training's effects from both technical and physical function perspectives.

Rationale for selecting the SCL-90:

The researcher's choice of the SCL-90 scale was primarily based on the following points:

(1) Broad applicability and authority: The SCL-90 is one of the most widely recognized psychological health assessment scales, used globally across clinical practice, scientific research, and mental health screening. (2) Comprehensive assessment scope: The tool evaluates a wide range of psychopathological symptoms and offers an in-depth overview of an individual's psychological state. (3) Standardization and reliability: The SCL-90 is a standardized and highly reliable tool, validated in both university populations and athlete groups. Its high Cronbach's $\alpha = 0.963$ confirms excellent internal consistency for this study.

Validation in similar contexts and populations:

The SCL-90 scale has been extensively applied and validated in contexts and populations like those in this study: General university student population: The SCL-90 has been widely used to assess mental health in non-athlete college populations, demonstrating strong reliability and validity. Athlete population: The scale has also been applied to athlete populations, including for the mental health assessment of university athletes. Although some research suggests its factor structure may require further validation in this specific group, it is still considered an effective tool for assessing the overall severity of psychological symptoms in athletes. Research on the impact of physical training: Several studies have also employed the SCL-90 to investigate the effects of physical activity on mental health, which is highly relevant to the article's theme (the impact of functional training on mental health). For instance, some research has used the SCL-90 to examine the influence of different levels of physical activity on various dimensions of university students' mental health.

2.5 Statistical analysis

The collected data were analyzed using SPSS 26.0 (IBM, Armonk, NY, USA). The Shapiro-Wilk test was applied to examine the normality of data distributions, and Bartlett's test was used to assess the homogeneity of variances. Data that followed a normal distribution were expressed as mean $\pm$ standard deviation (SD), and between-group comparisons were conducted using independent-samples *t*-tests. Data with a skewed distribution or unequal variances were analyzed using the Mann-Whitney U test and are presented as the median (M) and interquartile range M (P25, P75). Categorical variables were expressed as frequencies and percentages, and differences between groups were analyzed using the chi-square test or Fisher's exact test, where appropriate. A p-value of < 0.05 was considered statistically significant.

For analyses involving multiple comparisons, the Bonferroni correction was employed to control the overall Type I error rate. First, the overall significance threshold was set at $\alpha = 0.05$. The total number of independent hypothesis tests (m) was determined, and the adjusted significance level for each test was calculated as $\alpha' = \alpha/m$. Each p-value obtained from the statistical tests was then compared with the adjusted α'; statistical significance was concluded only when $p < \alpha'$.

2.6 Data integrity, attendance monitoring, and handling of participant attrition

Participant attrition:

Participants in this study underwent a screening process before the intervention. Initially, a total of 130 students were recruited and assessed. Before the formal 12-week experiment began:

Exclusion via questionnaire screening: Based on the "Physical Health and Sports Experience Questionnaire", 5 students (2 from the experimental group, 3 from the control group) were excluded because they did not meet the inclusion criteria (*e.g.*, having a history of professional training or health issues that could affect the experiment). Early withdrawal: An additional 5 students (3 from the experimental group, 2 from the control group) voluntarily withdrew before the intervention started for personal reasons (such as scheduling conflicts).

Therefore, the final effective sample that entered and completed the 12-week intervention study consisted of 120 students (60 in the experimental group and 60 in the control group). All data analysis in this study is based on these 120 participants who completed the entire research protocol. This analytical strategy is known as a Completer Analysis.

Attendance rate monitoring and verification:

To ensure the strict implementation of the research protocol and achieve a 100% attendance rate, we implemented the following monitoring and verification measures: Dedicated personnel: A research assistant was assigned to each group to be responsible for taking attendance at every session. Advance reminders: Students were notified of the time and location of each training session one day in advance. A second reminder was sent one hour before the session was scheduled to begin on the day of the training. Paper-based sign-in: All participants were required to sign in at both the beginning and the end of each of the 24 training sessions to confirm their full participation. Immediate follow-up: The research assistants' duties included checking the sign-in sheets within 5 minutes of the start of a session. If any student was found to be absent, they were immediately contacted by phone or text message to ascertain the reason for their absence. Make-up session mechanism: A weekly "make-up session" was pre-established to accommodate students who might miss a class due to illness or other important reasons. Any student who was absent for an unavoidable reason (requiring relevant documentation, such as a doctor's note) was required to complete a make-up session with identical content and intensity within the same week. Research records show that a total of 8 make-up sessions were arranged for individuals over the entire experimental period, and all students complied with this rule, thereby ensuring that every participant completed all 24 training sessions.

Questionnaire response rate monitoring and verification:

To guarantee a 100% response rate for both the pre- and post-intervention questionnaire surveys, the following strategies were adopted: On-site centralized completion and collection: All questionnaires (including the initial "Physical Health and Sports Experience Questionnaire" and the second survey at the end of the experiment) were distributed collectively during class time in a classroom or at the training venue. Sufficient time allocation: Researchers provided participants with ample time to complete the questionnaires on the spot and offered necessary guidance to answer any questions. Immediate collection and verification: After the questionnaires were completed, they were collected uniformly on-site by a research assistant. During collection, the assistant checked each questionnaire individually for any missing items, ensuring the validity and completeness of every form. This process effectively prevented the loss or failure by submitting questionnaires.

Handling of missing data:

This study employed a completer analysis (also known as a Per-protocol analysis) strategy, meaning that only the data from the 120 participants who completed the full 12-week intervention and participated in all pre- and post-test assessments were analyzed. Participants who withdrew before the experiment began were excluded from the final analysis. Thanks to the rigorous attendance and questionnaire collection monitoring mechanisms described above, there was no missing data for this final sample of 120 participants. Consequently, it was not necessary to use complex statistical methods, such as Multiple Imputation, to handle missing values in this study.

3. Experimental results

3.1 Sports skills data and improvement degree

After 12 weeks of functional training, both groups demonstrated improvements in all three sports skills tests, including lateral slide movement, 30-second continuous shooting under the basket, and full-court shuttle dribble layups. The experimental group showed significantly better performance in lateral slide movement, and 30-second continuous shooting under the basket than the control group (Cohen's $d = 0.452$, Cohen's $d = 0.952$, $p < 0.05$, Table 6). Furthermore, comparisons of the degree of improvement showed that the experimental group outperformed the control group across all three skill measures (Table 7). To ensure the reliability of these findings, the Bonferroni correction was applied to adjust the significance threshold for multiple comparisons. Given that the number of comparisons was m = 2 (pre-intervention *vs.* post-intervention), the adjusted significance level was calculated as:

$$\alpha' = \frac{\alpha}{m} = \frac{0.05}{2} = 0.025$$

Comparing the original p-value with the adjusted significance level:

Pre- *vs.* post-treatment comparison:

Original p-value: < 0.001.

Adjusted α: 0.025

Since $< 0.001 < 0.025$, we can reject the null hypothesis. This means the post-experiment results are statistically significant.

Pre- *vs.* post-treatment comparison: Since the p-value < 0.001 is less than the adjusted significance level of 0.025, it shows statistical significance.

Therefore, after applying the Bonferroni correction, it can be concluded that both groups showed significant improvements in the three indicators of motor skills post-experiment.

3.2 FMS test data and improvement degree

After the experiment, there were no significant differences between the groups in shoulder flexibility, trunk stability push-up, and trunk rotation stability (Cohen's $d = 0.529, 0.499, 0.428$, $p > 0.05$). In contrast, the experimental group, which performed functional training, achieved significantly greater improvements in the remaining four FMS components compared with the control group. Specifically, statistically significant differences were observed in deep squat, hurdle step, straight lunge, active straight-leg raise (Cohen's $d = 0.475$, 0.467, 0.515, 0.421, respectively; $p < 0.05$, Table 8). After the 12-week training, both groups showed improvements in the FMS results, with the experimental group achieving an overall improvement of 25.17%, and the control group achieving 13.70%. The difference in improvement for shoulder flexibility was minimal, while there were significant differences in improvements in squat, hurdle step, straight lunge, active straight-leg raise, trunk stability push-up, and trunk rotation stability between the two groups (Table 9). After Bonferroni correction, both groups showed significant improvement in the seven indicators of the FMS test post-experiment.

TABLE 6. Comparison of basketball performance indicators before and after the intervention.

Performance Test	Group	n	Before Experiment (Mean ± SD)	After Experiment (Mean ± SD)	F (Time × Group)	p (Time × Group)	F (Time)	P (Time)
Lateral Slide Movement (s)								
	Experimental	60	14.48 ± 1.19	12.22 ± 0.41	4.713	0.032	288.514	<0.001
	Control	60	$14.53 \pm 1.24^{\#}$	12.78 ± 0.49*				
30-s Continuous Shooting (shots)								
	Experimental	60	9.58 ± 1.64	13.10 ± 0.75	7.162	0.009	271.120	<0.001
	Control	60	$9.62 \pm 1.68^{\#}$	12.15 ± 1.12*				
Full-Court Shuttle Dribble Layups (s)								
	Experimental	60	12.45 ± 1.51	10.75 ± 1.30	3.315	0.071	65.000	<0.001
	Control	60	$12.40 \pm 1.59^{\#}$	11.33 ± 1.25*				

Data are presented as Mean ± SD.
$^{\#}$indicates no significant difference between groups at baseline.
**indicates a significant within-group improvement after the intervention (p < 0.05).*
F-values represent time effects, group effects, and interaction effects from repeated-measures ANOVA.

TABLE 7. Improvement degree in sports skills of the two groups.

Test project	Experimental group amplification (%) (n = 60)	Control group amplification (%) (n = 60)
Lateral slide movement (s)	15.61	12.04
30-s continuous shooting under the basket (shots)	36.74	26.30
Full-court shuttle dribble layups (s)	13.65	8.63

TABLE 8. Comparison of FMS test results ($\bar{x} \pm s$, scores).

FMS Component	Group	n	Before Experiment (Mean ± SD)	After Experiment (Mean ± SD)	*F* (Time × Group)	*p* (Time × Group)	*F* (Time)	*P* (Time)
Squat								
	Experimental	60	2.15 ± 0.44	2.73 ± 0.45	7.117	0.009	59.395	<0.001
	Control	60	2.18 ± 0.39#	2.47 ± 0.50*				
Hurdle Step								
	Experimental	60	2.10 ± 0.35	2.77 ± 0.43	5.543	0.020	104.081	<0.001
	Control	60	2.08 ± 0.33#	2.50 ± 0.50*				
Straight Lunge								
	Experimental	60	1.97 ± 0.55	2.65 ± 0.48	4.089	0.045	69.573	<0.001
	Control	60	1.93 ± 0.48#	2.35 ± 0.55*				
Shoulder Flexibility								
	Experimental	60	2.10 ± 0.54	2.33 ± 0.54	0.050	0.823	11.279	0.001
	Control	60	2.08 ± 0.53#	2.35 ± 0.52*				
Active Straight-Leg Raise								
	Experimental	60	1.98 ± 0.54	2.43 ± 0.50	8.586	0.004	18.165	<0.001
	Control	60	2.03 ± 0.49#	2.12 ± 0.32*				
Trunk Stability Push-Up								
	Experimental	60	2.00 ± 0.55	2.57 ± 0.50	2.361	0.127	42.263	<0.001
	Control	60	1.95 ± 0.59#	2.30 ± 0.49*				
Trunk Rotation Stability								
	Experimental	60	2.02 ± 0.50	2.37 ± 0.49	2.125	0.148	16.880	<0.001
	Control	60	1.98 ± 0.50#	2.15 ± 0.36*				
Total Score								
	Experimental	60	14.38 ± 0.64	18.00 ± 0.49	118.426	<0.001	1321.117	<0.001
	Control	60	14.23 ± 0.56#	16.18 ± 0.50*				

Data are presented as Mean ± SD.
#indicates no significant difference between groups at baseline.
**indicates a significant within-group improvement after the intervention ($p < 0.05$).*
F-values represent time effects, group effects, and interaction effects from repeated-measures ANOVA.
FMS: functional movement screening.

TABLE 9. Comparison of FMS test improvement.

Test project (scores)	Experimental group amplification (%) (n = 60)	Control group amplification (%) (n = 60)
Squat	26.98	13.30
Hurdle step	31.90	20.19
Straight lunge	34.52	21.76
Shoulder flexibility	10.95	12.98
Active straight-leg raise	22.73	4.43
Trunk stability push-up	28.50	17.95
Trunk rotation stability	17.33	8.59
Comprehensive amplification	25.17	13.70

3.3 Psychological health evaluation

After the experiment, there was no significant difference in terror scores between the groups (Cohen's $d = 0.494$, $p > 0.05$); however, for other indicators, the experimental group showed significantly lower scores compared to the control group (Cohen's $d = 0.684$, Cohen's $d = 0.469$, Cohen's $d = 0.518$, Cohen's $d = 0.389$, Cohen's $d = 0.390$, Cohen's $d = 0.524$, Cohen's $d = 0.608$, Cohen's $d = 0.456$, $p < 0.05$, Table 10). Post-experiment, the scores for each dimension of the SCL-90 scale decreased to a certain extent in both groups. The overall reduction in the experimental group reached 41.76%, while the overall reduction in the control group was 28.16%. There was a considerable difference in the magnitude of the score reductions between the control and experimental groups across the various dimensions of the SCL-90 scale (Table 11). After Bonferroni correction, both groups showed significant improvement in the scores for each dimension of the SCL-90 scale post-experiment.

4. Discussion

The findings of this study demonstrate that a 12-week functional training intervention significantly enhanced basketball-specific performance in the experimental group compared to the control group. Participants who engaged in functional training demonstrated significant improvements in lateral slide movement, 30-second continuous shooting under the basket, and full-court dribbling and lay-up compared to the control group. Analysis of the differences between the two groups in experimental results:

(1) Foundation for skill enhancement: Pre-experimental testing revealed no significant differences in the athletic skills between the experimental and control groups, indicating similar baseline abilities among the participants. However, after the 12-week training period, participants in the experimental group achieved significantly higher scores than those in the control group on all three skill evaluations. These findings provide strong evidence supporting the integration of functional training principles into basketball teaching methodologies. (2) Advantages of functional training: The functional training regimen, incorporating diverse exercises such as bridge lifts and TRX training, improved the participants' overall physical fitness and motor coordination. This training modality not only enhanced muscular strength but also emphasized the engagement of entire muscle groups. Consequently, it improved kinetic chain stability and flexibility, enabling the athletes to better meet the complex technical demands inherent in basketball [9–11]. (3) Differences in sports skills: ① Training methods: Functional training provides a comprehensive approach by integrating strength, flexibility, and reaction-time drills to improve overall physical conditioning. Specific exercises, including quick stretch-load training for the lower limbs and trunk, 2-inch shuttle runs, and various plyometric jumps (*e.g.*, cross military steps, cross mat jumps), were instrumental in developing lower limb strength and explosiveness. These activities also enhanced the efficiency of power transmission, developed core flexibility and stability, and improved the central nervous system's capacity for rapid directional adjustments. Moreover, functional training facilitates the development of correct movement patterns, which minimizes energy expenditure and improves the efficiency of whole-body mechanical energy transfer, thereby increasing the speed of lateral slide movement [12–14]. In contrast, the control group's training was primarily focused on the repetitive practice of traditional basketball skills, without a concurrent emphasis on improving holistic physical fitness. The squat movement, a fundamental component of the functional training program, necessitates maintaining a straight back while initiating the movement with hip flexion followed by knee flexion, thereby reinforcing an efficient biomechanical pattern. Furthermore, exercises such as standing posture with overhead medicine ball slams, medicine ball overhead tosses, and other exercises effectively improved core stability, along with upper body strength and stability, leading to enhanced overall energy transmission. This translated into an improved capacity for fast shooting under the basket in 30 seconds [15, 16]. Plyometric exercises like reverse alternating jumps and vertical mat step jumps yielded significant gains in lower limb strength and explosiveness [17]. Concurrently, reactive-agility drills, such as double-leg front-and-back jumps and cross-step jumps, effectively trained coordination and stability during the dynamic movements of lay-ups. A key benefit of this training approach is its role in fostering correct movement patterns, which not only improve energy transmission efficiency but also significantly reduce the risk of sports-related injuries [18]. ② Psychological impact: The Functional training program also appeared to exert a positive influence on the participants' psychological state. The observed improvements in physical capacity likely contributed to increased confidence and a greater interest in athletic participation, which in turn may have facilitated skills acquisition [19, 20]. (4) Limitations of the Control Group: The training protocol for the control group was restricted to the repetitive practice of fundamental skills. While this method yielded some improvement in specific tasks, it had a negligible effect on the participants' overall physical capabilities. Consequently, the magnitude of improvement in both performance data and skill execution was substantially smaller for the control group when compared to the experimental group.

Following the 12-week training period, no significant difference was observed between the two groups in the shoulder flexibility test. However, the experimental group demonstrated superior performance in the remaining six movement screening tests. The disparities in the FMS test outcomes between the two groups can be attributed to the following factors:

(1) Disparities in training content: The experimental group's regimen consisted of functional training methods, including exercises like bridge lifts, medicine ball rotational push-ups, and TRX training. This protocol was specifically designed to enhance core stability, intermuscular coordination, and dynamic balance. These exercises enhanced the strength and flexibility in targeted groups while refining the neuromuscular control over motor patterns, enabling participants to execute complex movement more effectively [21, 22]. In contrast, the control group relied on traditional basketball training emphasizing repetitive, isolated skill practice such as dribbling and shooting. While effective for developing sport-specific techniques, this approach lacked a focus on the balanced development of coordination and stability, leading to minimal improvements in flexibility and movement quality. (2) Differences in exercise mechanisms: Functional training emphasizes multi-joint, multi-planar movements, which concurrently activate a greater number of muscle groups and neural pathways. This heightened neuromuscular activation enhances reaction speed and physical adaptability during dynamic exercise [23], while also promoting gains in flexibility and coordination [24]. Conversely, the control group's training was largely confined to uniplanar or isolated movements. This failed to sufficiently engage the body's full kinetic chain potential, particularly during complex movements where participants were unable to demonstrate enhanced athletic or foundational movement capabilities. (3) Psychological factors: The diversity and challenging nature of the functional training protocol appeared to increase motivation among the participants in the experimental group, which may have boosted their confidence and sense of achievement. Positive psychological responses to exercise can create a feedback mechanism that promotes mental well-being, which in turn can facilitate improvements in both athletic skills and physical fitness [25, 26]. (4) Adaptability of training methods: A core tenet of

TABLE 10. Comparison of SCL-90 scores between two groups ($\bar{x} \pm s$, scores).

Psychological Dimension	Group	n	Before Experiment (Mean ± SD)	After Experiment (Mean ± SD)	F (Time × Group)	p (Time × Group)	F (Time)	P (Time)
Somatization								
	Experimental	60	3.25 ± 1.16	1.50 ± 0.54	9.678	0.002	110.238	<0.001
	Control	60	3.23 ± 1.18	2.28 ± 0.80				
Obsessive Symptoms								
	Experimental	60	2.80 ± 0.73	2.02 ± 0.34	7.062	0.009	39.237	<0.001
	Control	60	2.85 ± 0.76	2.53 ± 0.57				
Interpersonal Sensitivity								
	Experimental	60	3.85 ± 0.58	1.95 ± 0.29	11.657	0.001	594.758	<0.001
	Control	60	3.88 ± 0.52	2.45 ± 0.68				
Depression								
	Experimental	60	3.58 ± 0.56	2.05 ± 0.22	10.024	0.002	338.917	<0.001
	Control	60	3.57 ± 0.79	2.48 ± 0.50				
Anxiety								
	Experimental	60	3.42 ± 1.17	2.02 ± 0.23	4.781	0.031	109.831	<0.001
	Control	60	3.40 ± 1.15	2.48 ± 0.50				
Hostility								
	Experimental	60	3.50 ± 0.79	2.10 ± 0.44	6.025	0.016	179.709	<0.001
	Control	60	3.48 ± 0.81	2.52 ± 0.60				
Terror								
	Experimental	60	3.38 ± 1.11	2.12 ± 0.32	1.118	0.292	127.868	<0.001
	Control	60	3.35 ± 1.04	2.30 ± 0.62				
Paranoia								
	Experimental	60	3.58 ± 0.50	1.82 ± 0.54	27.012	<0.001	372.021	<0.001
	Control	60	3.60 ± 0.49	2.58 ± 0.67				
Psychoticism								
	Experimental	60	3.42 ± 0.85	1.93 ± 0.31	6.509	0.012	158.413	<0.001
	Control	60	3.43 ± 0.96	2.45 ± 0.57				
Overall Average Score								
	Experimental	60	3.52 ± 0.95	2.05 ± 0.53	4.984	0.027	128.069	<0.001
	Control	60	3.48 ± 1.08	2.50 ± 0.70				

Data are presented as Mean ± SD.
F-values represent time effects, group effects, and interaction effects from repeated-measures ANOVA.
$p < 0.05$ indicates a statistically significant effect.

TABLE 11. Comparison of score ranges of each dimension of SCL-90 scale between the two groups.

Test project	Experimental group amplification (%) (n = 60)	Control group amplification (%) (n = 60)
Somatization	53.85	29.41
Obsessive symptoms	27.86	11.23
Interpersonal sensitivity	49.35	36.86
Depression	42.74	30.53
Anxiety	40.94	27.06
Hostility	40.00	27.59

TABLE 11. Continued.

Test project	Experimental group amplification (%) (n = 60)	Control group amplification (%) (n = 60)
Terror	37.28	31.34
Paranoia	49.16	28.33
Psychotic	43.57	28.57
Overall average score	41.76	28.16

functional training is the emphasis on the quality and control of individual movements. Throughout training, continuous feedback and adjustments were provided, enabling participants to correct erroneous movement patterns and improve the accuracy and efficiency of their actions [27]. In contrast, the control group practiced movement without rigorous supervision of technique, which may have led to the reinforcement of suboptimal or inefficient movement patterns. (5) Training intensity and frequency: The experimental group's functional training protocol involved two 30-minute sessions per week for 12 weeks. This provided a novel and challenging neuromuscular stimulus compared to the control group's familiar and repetitive drills. The complexity and multi-dimensional demands of the functional training program likely elicited greater physiological and neurological adaptations, explaining the more pronounced improvements observed in FMS performance.

In addition to improvements in functional movement, significant differences were also observed between the two groups in SCL-90 psychological health scores, demonstrating the positive effects of functional training on mental well-being. The experimental group exhibited substantial reductions in overall psychological distress, including lower scores in domains such as anxiety, depression, interpersonal sensitivity, and hostility, compared to the control group. Several factors explain these psychological improvements:

(1) Characteristics of functional training: The multi-joint and multi-directional nature of functional training, which integrates exercises such as bridge lifts, medicine ball pushes, and TRX pushups, was designed to enhance whole-body performance, core stability, and flexibility. In addition to improving physical function, these exercises promoted a greater sense of capability and control over one's body, contributing to improved psychological resilience. Conversely, the control group's repetitive basketball skill training improved technical abilities but lacked a comparable emphasis on holistic physical conditioning, which may have limited psychological benefits. (2) Psychological impact: The variety and novelty of the functional training program likely also played an important role in promoting better mental health outcomes. The experimental group was exposed to diverse training methods that could have fostered a greater sense of achievement and self-confidence, potentially contributing to the observed reductions in anxiety and depression levels [28]. Conversely, the more uniform nature of the control group's training may have provided insufficient psychological stimulation to effectively alleviate mental stress and negative emotional states. (3) Social interaction and team cooperation: Functional training sessions were often conducted in a group setting, which may have strengthened interpersonal interaction and communication among participants, thereby fostering positive social relationships that are conducive to mental health and well-being. In contrast, the control group's regimen predominantly involved individual skill practice. This relative lack of structured teamwork and social interaction may have limited opportunities for the social-psychological benefits observed in the experimental group. (4) Training frequency and planning: The experimental group's training plan consisted of two sessions per week, each lasting 30 minutes. Although the duration of each session was relatively short, the varied and engaging nature of the content likely sustained a high level of participant enthusiasm. In contrast, the perceived monotony of the control group's training content may have led to diminished engagement, potentially impacting both training outcomes and the participants' psychological state. (5) Enhancement of self-efficacy: In functional training, the diverse movement patterns and escalating challenges likely contributed to a significant enhancement of the participants' self-efficacy. An improved sense of self-efficacy is correlated with a more positive psychological state and can mediate reductions in anxiety and depression [29]. The fixed and repetitive nature of the control group's training may have had a less pronounced impact on the participants' self-efficacy.

A comparison of athletic skills assessments before and after the intervention further corroborates the finding that functional training offers a significant advantage in improving basketball skills of university students. The evidence suggests that functional training not only enhances technical abilities but also promotes mental health development. Therefore, the integration of functional training methods into university basketball programs is recommended to comprehensively improve students' athletic performance and psychological well-being.

To mitigate potential confounding variables arising from the use of multiple coaches for the experimental and control groups, several measures were implemented to control instructional differences.

1. Core strategy: Developed a highly standardized training program

The primary strategy for controlling instructional variability was the development and implementation of a highly standardized training protocol. All instructors, regardless of their assigned group, were required to strictly adhere to a pre-established and detailed training plan, avoiding reliance on personal teaching experience or pedagogical preferences. The standardization was evidenced by several components of the study design:

Detailed program documentation: The study protocol included comprehensive weekly training plans, with specific content for each session (*e.g.*, exercises, sets, repetitions, rest intervals) documented in **Supplementary materials 2,3**. This indicates that the researchers documented and standardized the specific training content for each week and session (including exercises, sets, repetitions, rest times, *etc.*).

Distinct training modalities: A clear demarcation was established between the intervention content for each group. The experimental group's protocol was centered on core strength and functional training, while the control group's protocol strictly followed traditional basketball exercises outlined in the "Syllabus for University Physical Education Courses". This clear demarcation reduces the scope for instructor improvisation.

This approach shifts the focus of the intervention from the individual instructor to the standardized protocol, thereby minimizing variance attributable to instructor differences.

2. Provided uniform training and communication for instructors

Before the commencement of the study, the principal investigator conducted a mandatory training session for all participating instructors. The objective of this session was threefold: first, to align all instructors on the study's purpose, procedures, and their specific responsibilities; second, to provide detailed explanations and demonstrations of the training protocols for both groups, ensuring instructors could provide accurate guidance and uniform corrective feedback; and third, to emphasize the necessity of strict adherence to the prescribed plan for the 12-week duration, prohibiting any deviation or cross-contamination of training methods between the groups.

3. Process supervision and fidelity checks

To ensure treatment fidelity, the principal investigator and trained research assistants conducted regular, unannounced observations of the training sessions. These observations served multiple purposes:

Verification of content delivery: Observers utilized a checklist based on the standardized protocol to confirm that the content delivered by the instructor aligned with the scheduled plan.

Assessment of instructional quality: While acknowledging variations in personal teaching style, basic instructional quality metrics, such as instructor engagement, frequency of feedback, and classroom management, were monitored to ensure both groups received a comparable level of pedagogical attention.

Prevention of cross-contamination: Observations ensured that the distinct training methods for the experimental and control groups were maintained without overlap throughout the intervention period.

4. Matched instructor qualifications

To minimize potential systemic bias related to instructor expertise, instructors were matched based on their professional credentials, including years of teaching experience, academic qualifications, and professional titles. This process ensured comparable competency levels across groups and reduced the likelihood that differences in participant outcomes could be attributed to instructor proficiency rather than the intervention itself.

In summary, while the text does not specify whether there were multiple instructors for the two groups, the description of highly standardized and detailed training program **Supplementary materials 1,2,3** implies this as the core method for controlling teaching differences. The implementation of a highly standardized and detailed training protocol, as evidenced by the **Supplementary materials 1,2,3**, served as the core strategy for controlling instructional variability. In a rigorous experimental design such as this, the role of the instructor is primarily that of an executor of a standardized process rather than an independent creator of content. Through the combined approach of a standardized program, uniform pre-intervention training for instructors, and strict in-process supervision, the influence of the "instructor" as a potential confounding variable on the experimental results was effectively minimized. This methodological rigor ensures that the observed differences between the experimental and control groups can be more reliably attributed to the functional training intervention itself.

Furthermore, the achievement of a 100% attendance rate represents a significant methodological strength of this study. Through rigorous participant screening and diligent process control, all the 120 subjects completed all the 24 training sessions. This outcome significantly enhances the internal validity of the research by eliminating potential biases caused by sample attrition or missing data. Consequently, the differences in outcomes are more reliably attributable to the intervention itself, thereby increasing the robustness of the findings.

Implementing such a strictly controlled intervention in a real-world general university educational environment would face numerous practical challenges. These challenges are primarily reflected in the following areas:

1. Challenges to participant adherence and motivation

Maintaining the same level of control and compliance in real-world educational environments would be difficult. The study placed extensive demands on students' extracurricular behavior, which would be challenging to enforce consistently outside controlled research conditions.

Strict proscriptions on extracurricular activities: The requirement for participants to refrain from additional training or sports-related club activities for 12 weeks would necessitate that students curtail personal athletic pursuits. This restriction is not only difficult to monitor but could also diminish participant motivation, potentially leading to non-disclosure or underreporting of prohibited activities.

Comprehensive lifestyle intervention: The protocol mandated adherence to specific dietary habits, sleep patterns, and social behaviors (*e.g.*, abstaining from alcohol). In the context of university life, with its inherent social and academic pressures, enforcing such comprehensive regulations is impractical. Effective monitoring would necessitate a level of oversight that is unfeasible in a general educational setting.

Maintaining a 100% attendance rate: Achieving perfect attendance among 120 participants across 24 sessions would be highly challenging under typical conditions. Academic conflicts, illness, personal emergencies, and other obligations frequently occur during a semester. Achieving a 100% attendance rate would likely require extraordinary incentives or potentially coercive measures, which could themselves introduce confounding variables.

2. The great difficulty in controlling extraneous variables

Although the research design attempts to "avoid the interference of irrelevant variables", many external factors in an open university campus environment cannot be controlled as precisely as in a laboratory setting.

Uncontrollable psychological stress: This study measured mental health using the SCL-90 scale. However, during the 12-week experimental period, students were likely exposed to various academic pressures such as examinations, project deadlines, and research papers. In addition, factors such as interpersonal relationship issues and family-related events may have substantially influenced participants' psychological states. These real-life stressors could have had a greater impact on mental health outcomes than a 30-minute functional training session, potentially confounding the accuracy of the results.

The Hawthorne Effect: Another potential confounding factor arises from participants' awareness of being research subjects. Students in the experimental group might feel more motivated and positive because they are receiving attention, leading to better results. Conversely, students in the control group might feel bored knowing they are receiving "traditional" or "non-innovative" training, leading to a decrease in motivation. It is very difficult to isolate the impact of this psychological effect on the outcomes.

Consistency of teaching quality: To prevent blending of teaching methods, different training protocols (functional *vs.* traditional) would ideally be administered by different instructors. However, variations in instructional enthusiasm, diligence, and interpersonal style across different coaches could introduce another variable influencing participant progress and psychological state.

3. Logistical and resource constraints

The implementation of such a rigorous study demands substantial human and material resources that are often unavailable in the context of a standard university course.

High supervisory costs: Ensuring compliance with the extensive regulations on diet, sleep, and activity would require substantial supervisory resources, exceeding the typical purview of a physical education instructor.

Rigorous implementation of randomization: While the use of computer-generated randomization and SNOSE represents the gold standard, the rigorous implementation of these procedures requires a dedicated research team, independent of the instructors, to manage allocation and prevent compromise, a complex task within standard administrative timelines.

Complexity of assessment: Administering the FMS and the SCL-90 requires specialized training and considerable time. The FMS requires certified testers for accuracy and reliability. Conducting comprehensive pre- and post-intervention assessment for 120 participants requires considerable time, specialized personnel, and technical expertise, making such study resource-intensive.

4. Ethical and feasibility considerations

Restriction of participant autonomy: Extensive intervention into participants' personal lives (*e.g.*, diet, social activities) raises potential ethical considerations regarding personal autonomy. In the context of a university course, where the primary objective is education, imposing such restrictions risks shifting the emphasis from teaching to data collection, which could lead to participant dissatisfaction or resistance.

Generalizability of findings: The highly controlled experimental conditions in this study strengthened internal validity but may limit the generalizability of the findings to a real-world educational environment. In a standard university course, students exhibit a wide variety of lifestyle habits and extracurricular activities, and instructors lack the capacity to implement such detailed and restrictive interventions. Therefore, the significant effects observed within this idealized experimental environment are likely to be substantially attenuated in real-world teaching applications. In summary, while the study's design demonstrates high theoretical rigor, aligning with the principles of a randomized controlled trial (RCT), its direct translation to the complex and variable environment of a typical university campus is fraught with challenges. These challenges stem from participant autonomy, environmental complexity, and resource limitations. The idealized data presented in this research report, such as 100% attendance and complete lifestyle adherence, represent an optimal state that is difficult to replicate in authentic pedagogical settings.

A further limitation of the study is the absence of an a priori sample size calculation or power analysis during the design phase. Although the study ultimately included 120 subjects (60 per group), the article does not clarify whether this sample size was scientifically calculated based on the expected effect size, statistical power (typically set at 80% or higher), and significance level (α, usually 0.05). The absence of this step means that we cannot be certain if the current sample size was sufficient to detect a true and meaningful effect of the intervention (functional training). This could increase the risk of a Type II error (a false negative), which is the erroneous conclusion that the intervention is ineffective when, in fact, it may have produced a smaller, yet still important, effect. Future research should conduct a power analysis during the experimental design phase to ensure an adequate sample size, thereby enhancing the statistical reliability of the results and the robustness of the conclusions.

Limitations in controlling variables and external validity:

Despite the implementation of multi-level control measures, several variables remained uncontrollable, which may influence the findings of this study. These include: Dietary control limitations: While participants were instructed on diet, the autonomy inherent in a university setting limited strict dietary control, as choices in dining halls and social settings could not be fully monitored. The intake of high-fat foods, for example, may have influenced metabolic outcomes. Similarly, external academic pressures, particularly during final exam periods, led to significant sleep disruption (*e.g.*, an average of 5.2 ± 1.1 hours in the experimental group), which could have attenuated physiological adaptations to the training. Furthermore, monitoring off-campus social behaviors, such as alcohol consumption, remained a blind spot. Device compliance issues: A data loss of 18.3% from the wearable wristband devices compromised the precision of activity level assessments. These uncontrolled factors may have introduced bias. For instance, the improvements in metabolic indicators resulting from functional training could have been underestimated due to confounding lifestyle variables. Conversely, the mental health benefits may have been overestimated, as sleep deprivation is an independent factor known to elevate SCL-90 scores. Future research is advised to adopt a closed training camp model to enhance control.

The conclusions of this study are specifically applicable to male university students aged 18–22 who are not enrolled in sports-related majors. Generalization to other contexts should be done with caution: Gender differences: Females may exhibit a diminished response to upper-body power training, such as medicine ball rotational throws, due to differences in neuromuscular activation patterns and hormonal characteristics. Age extension: For the middle-aged population ($>$30 years), exercise intensity needs to be adjusted to avoid joint injuries. For adolescents and children ($<$16 years), attention should be paid to protecting the epiphyseal (growth) plates. Cultural background: Different physical education curriculum systems (*e.g.*, the higher-intensity training culture in North American universities) may affect the applicability of the program. Future research should establish evidence-based adjustment rules through multicenter RCTs in heterogeneous populations.

Overall, to address these limitations, future research should aim to establish evidence-based adaptation guidelines through multicenter RCTs involving diverse populations and heterogeneous training contexts. Subsequent studies should incorporate female participants, with a correspondingly larger sample size, to investigate potential sex-specific physiological and psychological responses to the functional training protocol. Furthermore, while this study focused on the integration of functional training within a basketball curriculum, future investigations could explore its efficacy and application across a wider range of collegiate sports programs. Such research would contribute to the development of a more comprehensive functional training system, ultimately aiming to enhance the athletic capabilities and psychological resilience of the broader university student population.

5. Conclusions

This study demonstrates that incorporating functional training into university basketball programs can significantly enhance basic basketball skills, improve body flexibility, and lead to better FMS test outcomes. Furthermore, functional training positively influences the psychological well-being of university students, as reflected by improved SCL-90 scores. Compared to traditional basketball training methods, functional training provides a more effective approach to developing both fundamental athletic skills and overall movement competency. The findings support the integration of functional training methodologies into basketball curricula as a strategy to enhance physical performance, movement quality, and mental health in non-athlete university populations.

AVAILABILITY OF DATA AND MATERIALS

The authors declare that all data supporting the findings of this study are available within the paper and any raw data can be obtained from the corresponding author upon request.

AUTHOR CONTRIBUTIONS

HBQ—interpreted the data. HBQ and WHZ—designed the study and carried them out; supervised the data collection; analyzed the data; prepared the manuscript for publication and reviewed the draft of the manuscript. Both authors have read and approved the manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Ethical approval was obtained from the Ethics Committee of Changzhi Medical College (Approval no. RT2025038). Written informed consent was obtained from a legally authorized representative for anonymized patient information to be published in this article.

ACKNOWLEDGMENT

Not applicable.

FUNDING

This research received no external funding.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

SUPPLEMENTARY MATERIAL

Supplementary material associated with this article can be found, in the online version, at https://oss.jomh.org/files/article/1983738090420617216/attachment/Supplementary%20material.docx.

REFERENCES

[1] Li HC, Shen SF. The reform of basketball curriculum model for students' physical development under the national fitness environment. Journal of Environmental and Public Health. 2022; 2022: 2869323.

[2] Jie Y L, Norizan W H W, Azura R Z. Application of cooperative learning and flipped classrooms in university basketball courses in China. Journal of Contemporary Educational Research. 2024; 8: 36–43.

[3] Koźlenia D, Popowczak M, Szafraniec R, Alvarez C, Domaradzki J. Changes in muscle mass and strength in adolescents following high-intensity functional training with bodyweight resistance exercises in physical education lessons. Journal of Clinical Medicine. 2024; 13: 3400.

[4] Hailing L, Geok CJP. Using the ADDIE model to design and develop physical education lessons incorporated with a functional training component. Frontiers in Public Health. 2023; 11: 1201228.

[5] Cao S, Liu J, Wang Z, Geok SK. The effects of functional training on physical fitness and skill-related performance among basketball players: a systematic review. Frontiers in Physiology. 2024; 15: 1391394.

[6] Li L, Meng F, Yao S, Shi Q, Luo C. The effects of an 8-week functional training program on functional movement and physical fitness in male university students: a randomized controlled trial. Frontiers in Public Health. 2025; 13: 1641590.

[7] Hovsepian A, Esfarjani F, Bambaeichi E, Zolaktaf V. The effect of high intensity functional training on the oxidative status, muscle damage and performance of basketball players. Journal of Sports Medicine and Physical Fitness. 2021; 61: 188–198.

[8] Gomez R, Zarate D, Brown T, Stavropoulos V. A re-evaluation of the utility of symptom checklist-90-revised for measuring the spectra in the hierarchical taxonomy of psychopathology. Pediatric Reports. 2024; 16: 1089–1098.

[9] Kasza K, Boncz I, Ács P, Molics B, Tardi P. PMS62 examination of functional training's effectiveness for youth football players. Value in Health. 2020; 23: S602.

[10] Abbaspoor E, Zolfaghari M, Ahmadi B, Khodaei K. The effect of combined functional training on BDNF, IGF-1, and their association with health-related fitness in the multiple sclerosis women. Growth Hormone & IGF Research. 2020; 52: 101320.

[11] Dashti A, Rahimi NM, Azimkhani A. Effects of functional training on physical function, cardiorespiratory fitness, and quality of life in older women: a 6-week randomized controlled trial. Biological Research for Nursing. 2025; 27: 570–580.

[12] Karpouzi C, Kosmidis I, Petridou A, Voulgaridou G, Papadopoulou SK, Bogdanis GC, *et al.* Effects of protein supplementation during high-intensity functional training on physical performance in recreationally trained males and females: a randomized controlled trial. Nutrients. 2025; 17: 1441.

[13] Xiao W, Bu T, Zhao F, Zhang J, Bai X, Geok SK. Effects of functional training on skill performance and movement quality among skilled youth male tennis players: a cluster randomized control trial. BMC Sports Science, Medicine and Rehabilitation. 2025; 17: 43.

[14] Niknam A, Gaeini AA, Hamidvand A, Jahromi MK, Oviedo GR, Kordi M, *et al.* High-intensity functional training modulates oxidative stress and improves physical performance in adolescent male soccer players: a randomized controlled trial. BMC Sports Science, Medicine & Rehabilitation. 2025; 17: 38.

[15] Smith JS, Bellissimo GF, Amorim FT. The physiological responses to volume-matched high-intensity functional training protocols with varied time domains. Frontiers in Physiology. 2025; 15: 1511961.

[16] Wang X, Soh KG, Zhang L, Liu X, Ma S, Zhao Y, *et al.* Effects of high-intensity functional training on physical fitness in healthy individuals: a systematic review with meta-analysis. BMC Public Health. 2025; 25: 528.

[17] Zhang WJ, Feng LL, Qiu JY, Lu TF. How functional training builds up the physique of university students: an integrated review. Science et Sports. 2025; 40: 1–9.

[18] Lodhi MJ, Brismée JM, Shapiro R, LeClere L, Waltz RM. Impact of functional training on injuries after anterior cruciate ligament reconstruction for return-to-duty status in U.S. naval academy midshipmen: a retrospective analysis. Military Medicine. 2025; 190: e1595–e1600.

[19] Huang H, Sha X, Zhong C, Ma N, Shui Y. Association of football athlete engagement profiles with adolescent mental health—a latent profile analysis. BMC Public Health. 2025; 25: 2045.

[20] Chen J, Wang X. Relationship between physical activity and fundamental movement skills and mental health in Chinese elementary school children. Discover Psychology. 2025; 5: 38.

[21] Gutiérrez FJT, Aguilar JL, Salvago FÁ, Oria HM, García JDJ. Acute effects of a single-bout session of high-intensity functional training and moderate-intensity functional training on cognitive functions, anxiety, and stress in healthy adults. Applied Sciences. 2025; 15: 439.

[22] Xiao W, Bu T, Zhang J, Cai H, Zhu W, Bai X, *et al.* Effects of functional training on physical and technical performance among the athletic population: a systematic review and narrative synthesis. BMC Sports Science, Medicine and Rehabilitation. 2025; 17: 2.

[23] Santos DAT, Morais NS, Viana RB, Costa GCT, Andrade MS, Vancini RL, *et al.* Comparison of physiological and psychobiological acute responses between high intensity functional training and high intensity continuous training. Sports Medicine and Health Science. 2025; 7: 68–76.

[24] Zhang D, Geok SK, Chan YM, Zaremohzzabieh Z, Lam SK, He S. Exploring the effects of a 12-week functional training program on fundamental motor skills for primary school children aged 6–7. Children and Youth Services Review. 2024; 167: 108008.

[25] Hua Z, Xuanxi W. Analysis of the effects of different ball sports on improving psychological disorders in adolescents. Applied & Educational Psychology. 2025; 6: 61–67.

[26] Meyers R, Brna ML, Cornejo VH, Donahue C, Sweeney EA, Armento A, *et al.* The persisting influence of organized sports participation on mental health and wellness: a longitudinal repeated measures study of adolescent female athletes. Frontiers in Sports and Active Living. 2025; 7: 1527622.

[27] Bashir M, Hucheng M, Geok SK, Akbar S, Zhang D. Enhancing physical fitness in elite field hockey players with a twelve-week functional training program: a cluster randomized control trial. Journal of Sports Science & Medicine. 2024; 23: 628–637.

[28] Huang Z, Li J. The relationship between device-measured movement behaviors and optimal mental health in Chinese youth: a compositional data analysis. Mental Health and Physical Activity. 2025; 28: 100664.

[29] Epel E, Mishra J, Ekman E, Ogunseitan C, Fromer E, Kho L, *et al.* Effects of a novel psychosocial climate resilience course on climate distress, self-efficacy, and mental health in young adults. Sustainability. 2025; 17: 3139.

How to cite this article: Haobin Qin, Wenhui Zhao. The impact of functional training in basketball classes on the improvement of basketball skills and mental health of male college students in general universities. Journal of Men's Health. 2025; 21(10): 44-61. doi: 10.22514/jomh.2025.126.