Academic Journal of Thailand National Sports University
ปีที่ 18 ฉบับที่ 1 (มกราคม - เมษายน 2569) Vol. 18 No. 1 (January - April, 2026)

RESEARCH AND DEVELOPMENT MODEL CONSTRUCTION OF PERFORMANCE TESTS AND EVALUATION OF ELITE UNIVERSITY BASKETBALL PLAYERS

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Abstract:

This study aims to develop a test of criteria for selecting high-level basketball players. and study the efficiency and effectiveness of evaluation standards for high-level university basketball players in China. Using qualitative research methods and sample group used in this study consisted of were 16 basketball coaches and assistant coaches at the basketball level in the Southeast Division of the Chinese University Basketball. The criteria for inclusion are as follows: with a minimum of 1 year of coaching experience at the senior national (i.e., club coach in a country's highest senior league) or international level (i.e., national coach in an International Basketball Federation (FIBA) tournament or Olympic Games) within the past 5 years (from initial recruitment). Participant coaches were identified from as many of the CUBAL as possible and the instrument used in the research include: In-depth interview created from a review of relevant literature and theory and distribution of 5 experts, reviews and comments for the accuracy of the interview form. Research methods: 16 basketball coaches and assistant coaches at the basketball were interviewed, using the analytical hierarchy method (AHP) and the fuzzy comprehensive evaluation method. To assess the comprehensive qualities of outstanding male university basketball players.

The research results found that: Through analysis, the evaluation indicators for comprehensive qualities and the weights of each testing indicator were determiner. Based on subjective qualitative analysis by coaches, a single score sheet was established, along with a set of evaluation criteria.

Conclusion: The assessment system provides athletes and coaches with scientifically rigorous measurement and judgment tools. This helps in accurately identifying an athlete's strengths and weaknesses. It also offers a reliable basis for developing training plans. Setting training goals and selection of training content and methods.

Keywords: Elite basketball players, performance test and evaluation

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Introduction

Testing is a vital component in the realm of competitive sports, serving as a cornerstone for evaluating athletes' capabilities and refining training programs to enhance their competitive performance in real-time (Haff, & Triplett, 2021). It holds particular significance in the identification and development of talent, as it enables the establishment of precise criteria for talent selection by identifying key performance indicators through data comparison (Glassbrook et al., 2022). However, it is crucial that the content and standards of testing take into account the practical needs and differences of athletes to ensure fair and objective assessment (Drinkwater, Pyne, & Mckenna, 2008). The overarching objective is to foster the development of exceptional athletes through a scientifically informed training and selection system, injecting renewed vitality into the growth of basketball within our country (Pyne, Montgomery, Klusemann, & Drinkwater, 2011; Abdelkrim, Chaouachi, Chamari, Chtara, & Castagna, 2010). This test will be a guideline for development, for example, it only enhances an athlete's abilities and improves their competitiveness. But it also provides valuable insights for coaches and sports administrators. To optimize training programs and selection mechanisms (Torres - Unda et al., 2016).

Moreover, it is imperative to prioritize the scientific nature and effectiveness of testing, continuously refining methodologies and standards to adapt to evolving competitive environments and athlete requirements. In summary, testing occupies an indispensable position in modern competitive sports and warrants ongoing attention and in-depth research to drive continuous improvement in our sporting endeavors. In the domain of basketball, various assessment tools such as the NBA Combine and Basketball Australia test batteries are utilized to evaluate players' physical and technical abilities (Bezmylov, Shynkaruk, & Murphy, 2020; Pomeshchikova, et al., 2018). These batteries encompass measures spanning physical attributes and technical skills, yet there remains a lack of consensus among elite coaches regarding the most pivotal indicators for player recruitment and selection (to this gap, the study utilizes the Delphi method, a structured consensus approach among experts, to determine key non-game performance indicators that elite coaches consider essential for recruiting and selecting basketball players. (Matulaitis, Skarbalius, Abrantes, Gonçalves, & Sampaio, 2019). Originating in the 1950s, the Delphi procedure facilitates reliable consensus gathering from independent experts over multiple rounds, particularly valuable when experts cannot convene simultaneously (Teramoto, Cross, Rieger, Maak, & Willick, 2018). The findings of this Delphi study have the potential to inform the development of a basketball - specific test battery for recruiting, selecting, and monitoring players, thus guiding more the findings of this Delphi study have the potential to inform the development of a basketball - specific test for recruiting, selecting, and monitoring players, thus guiding more targeted research for meaningful in the realm of basketball.

Research objectives

To study and development model construction of performance tests and evaluation elite university basketball players.

Hypothesis

University basketball teams lack adequate basic research on modern basketball. And there is an urgent need to improve the athlete evaluation model and selection criteria. When there is a standardized test, it will make the selection of athletes more efficient.

Research Methods

The Analytic Hierarchy Process (AHP) has been method widely used in the field of social science research, particularly in the comprehensive evaluation of a social phenomenon or behavior (Li, & Zhang, 2018). The objective of this study was to construct an evaluation index system for the competitive qualities of high-level male basketball players in universities. Therefore, the AHP is particularly suitable for the objectives of this study. This research utilizes the AHP to analyze the importance of each indicator at different levels within the evaluation system for the competitive qualities of basketball players. This process forms corresponding judgment matrices and scientifically evaluates the weights of various indicators at each level. Considering the characteristics of basketball players as a group, a three-level objective structure model was established. In this study, two categories of secondary indicators were designed: Physical Test (PT) and Technical Capability Evaluation Index (TCEI), including 11 specific measurement methods as tertiary indicators, in accordance with the requirements of the Chinese University Basketball Association (CUBA) for outstanding male basketball players. The Delphi method was used for two rounds of selection involving 16 experts. Ultimately, the test methods with the highest expert support rates were chosen as evaluation indicators for assessing athlete performance. Subsequently, the finalized test indicators were transformed into a survey questionnaire. Finally, the weights of the secondary and tertiary indicators were determined using the Analytic Hierarchy Process (AHP).

The Fuzzy Comprehensive Evaluation Method is typically used for handling problems with fuzziness or uncertainty. In this method, through analysis and evaluation of the problem, considering the interrelationships and weights of different factors, a comprehensive evaluation result is obtained. After constructing the evaluation index system for the competitive qualities of university level basketball players using the AHP, further validation of this index system's feasibility is required. For validation, this study selected athletes from the men's basketball team at Ningbo University

as the subjects and conducted a scientifically reasonable evaluation of their sports intelligence using the Fuzzy Comprehensive Evaluation Method.

Materials and methods

In order to validate the importance of different indicators in the evaluation process of basketball player's competitive quality evaluation model, it's essential to compare the indicators at different levels within the model. This comparison allowed for a clearer understanding of each indicator's role in assessing the players' performance on the court. To emphasize the significance of quality assessment, the approach establishes a comparative matrix for the basketball player's competitive quality evaluation index system. Expert on before the weight assignment of the two indicators, it is necessary to determine the quantitative criteria of subjective thinking judgment, and adopt the ratio scale method of mathematical quantification, that is, the importance level is used to represent the judgment results of experts, and the judgment matrix is constructed in turn. Construct different indicators in the model around hierarchical levels, and with the help of the 1-9 ratio scale proposed by Saaty (Yixiong, et al., 2019)

Indicator Weight Calculation and Consistency Verification.

After establishing the judgment matrix and completing the expert questionnaire survey, the following steps were undertaken using the YAAHP software for the calculation of indicator weights and consistency verification of the survey results. In indicator weight calculation, when using the Analytic Hierarchy Process (AHP) to determine weights, it usually involves calculating the maximum eigenvalue of the judgment matrix. The judgment matrix is composed of pairwise comparisons, reflecting the relative importance of different indicators. Assuming the judgment matrix is A, and its maximum eigenvalue is usually denoted as λmax. To find this maximum eigenvalue, standard methods of linear algebra, such as the power method or Jacobi method, can be used. However, in practical applications, especially when using the Analytic Hierarchy Process, a simplified approximation method is often adopted to estimate λmax.

This method is based on the consistency check of the judgment matrix A. The consistency check is performed by calculating the Consistency Index (CI) and Consistency Ratio (CR). In this process, the estimation formula for λmax is as follows:

$$\lambda \max = \frac{1}{n}\sum_{i=1}^{n}\frac{(AW)i}{Wi} \quad (1)$$

Calculating the Consistency Index (CI):

$$CI = \frac{\lambda_{max} - n}{n-1} \quad (2)$$

n is the order of the judgment matrix A (i.e., the number of indicators). $(AW)_i$ is the i_{th} element of the vector obtained by multiplying the judgment matrix A with the weight vector W_i is the i_{th} element of the weight vector W. This weight vector is usually obtained by solving the eigenvector corresponding to the maximum eigenvalue of the judgment matrix A and then normalizing it.

Random Index (RI):

The value of RI depends on the order of the judgment matrix and can typically be found in a predefined table. To find the Consistency Index (CI), refer to the table system below for all judgment matrices. If all Consistency Ratios (CR) values are within the range $0 \leq CR < 0.1$, it meets the basic consistency condition.

Research Instrument

In the literature retrieval databases PubMed, Google Scholar, and Sport Discuss, relevant literature from 2001 to 2024 was searched using keywords such as basketball, agility, speed, testing, Youth basketball players, technical test and evaluation, and Index system. The citation library was managed using the reference management software Mendeley (Elsevier, Netherlands 1880). Online surveys and questionnaire distribution were conducted using WJX software ("WJX", Changsha Ran Xing Science and Technology, Changsha, China) (Liang, Huang, Huang, & Weng, 2022) and the reliability test of the three questionnaires, the consistency test of the evaluation structure model, and the weight coefficient calculation of the three indexes in the hierarchical analysis method.

Data Analysis Method

This study involved a number of data in the process of constructing the evaluation index system of high-level basketball players in universities, so the relevant data is statistically analyzed with the help of SPSS20.0 software. It mainly included the Pearson Correlation reliability coefficient statistics.

Results

Determination of Comprehensive Quality Assessment Indicators

After expert questionnaire surveys, principal component and factor analysis, R - type cluster analysis, and qualitative analysis based on professional logic, the final testing indicators for physical fitness were determined (testing methods omitted), as shown in Table 1. The agreement rate among experts for these 11 comprehensive quality measurement methods is above 80%, indicating a high level of validity with approval from over 80% of experts.

Table 1 Testing Indicators and Representative Qualities

Test index	Qualities of Representatives
The Lane Agility Test (LAT)	Speed
The Running Anaerobic Sprint Test	Agility
Bench Press test	Upper strength
Maximum jump reach (MJR) (cm)	bounce
Shuttle run test	anaerobic capacity
2-minute Inside-Outside Three-Point Shooting Percentage for Self-Shots and Offensive Rebounds (TSPSOR)	3 points shooting ability
Field Goal Percentage for Inside-the-Paint	
Two-Point Shots with Self-Shooting and Self- Rebounding Within 2 Minutes (FGPSOR)	2 points shooting ability
Full-court Dribble and Layup (FDI)	Ball-handling
Perimeter Catch and Dribble Drive (PCDD)	Dribbling skills
Interior Catch and Dribble Drive (ICDD)	Defensive ability
hexagonal movement (HM)	Mobility

Establishment of Evaluation Criteria for Physical Fitness of Outstanding Male Basketball Players

The ranks sum method was employed to calculate the weights. Finally, the weights of each indicator were calculated using the weighting formula. Specific results are shown in Table 2.

Table 2 Weighting of Testing Indicators

First-level indicators	Weight Value	Second-level indicators	Weight Value	λ_{max}	CI
Physical Test	0.6	LAT	0.052	6.410	0.082
		RAST	0.084		
		BPT	0.184		
		MJR	0.503		
		SRT	0.177		
Technical capability evaluation index(TCEI)	0.4	TSPSOR	0.391		
		FGPSOR	0.229		
		FDI	0.190		
		PCDD	0.103		
		ICDD	0.054		
		HM	0.030		

The establishment of Single-item Scoring Table

In formulating the evaluation criteria for comprehensive qualities of elite male basketball players, the author adopted the percentile method to grade the test indicators of excellent male basketball players. Tables 3 display partial percentile tables of 11 comprehensive quality tests for outstanding male basketball players in universities. This scoring method can intuitively reflect the position score of the tested object's certain physical qualities within the entire group, facilitating coaches and athletes in measurement and assessment.

Table 3 Scorecard for Individual Qualities of Outstanding Male Basketball Players

SCORE	100	90	80	70	60	<60
LAT(s)	< 4.5	4.6-5	5.1-5.5	5.6-6	6.1-6.5	> 6.5
RAST(s)	< 3.5	3.6-4	4.1-4.5	4.5-5	5.1-5.5	> 5.5
BPT	> 45	40-44	35-39	30-34	25-29	< 25
MJR(m)	< 3.6	3.51-3.59	3.41-3.5	3.31-3.4	3.21-3.3	< 3.21
SRT(s)	< 100	100-115	116-125	126-135	136-145	> 145
TSPSOR%	40	33	26	20	13	< 13
FGPSOR%	43	36	29	23	16	< 15
FDI(s)	21.17	27.45	33.73	39.11	45.39	> 45.4
PCDD(s)	11.43	12.52	13.61	14.55	15.64	> 15.64
ICDD(s)	14.22	15.41	16.6	17.62	18.79	> 18.8
HM(s)	14.72	15.93	17.14	18.18	19.39	> 19.4

Determine the membership function

To objectively analyze and evaluate the comprehensive performance level of a high - level basketball player at a certain university, it is necessary to use a real case to validate the accuracy of the evaluation criteria. First, the coach was asked to score according to different evaluation criteria, and then converted them into statistical values.

Based on the above function, the scores given by the coach for various indicators in the comprehensive evaluation of high-level university basketball players can be converted into evaluation scores. This will help to understand the evaluation results more clearly.

The establishment of evaluation criteria set

Based on the previously constructed system of comprehensive evaluation indicators for high - level university basketball players, a two-tier evaluation factor set is formulated for establishing the fuzzy comprehensive evaluation. The symbol U represents the overall quality of high-level university basketball players, and the specific evaluation factor set is as follows: According to U, which represents the evaluation factor set of high-level university basketball players. Ui = {U1, U2, U3, ..., Un}, where i = (1, 2, 3, ..., n) represents the primary indicators. Uj= {Uj1, Uj2, Uj3, ..., ujm}, where j = (1, 2, 3, ..., m) represents secondary indicators. Let Cj = (Cj1, Cj2, Cj3, ..., Cjm) denote the weights of primary indicators, and let the corresponding weights of secondary indicators be denoted by Ci = (Ci1, Ci2, Ci3, ..., Cim), which are obtained based on expert assessments. At the same time, let Di (i = 1, 2, ..., n) represent the scores given by the coach converted into corresponding membership degrees, and let Ri (1, 2, ..., n) represent the set of secondary indicators Uj. The weighted average method was used to determine the comprehensive evaluation results, and the evaluation levels were allocated as follows: "Excellent" is 95 points, "Good" is 85 points, "Fair" is 75 points, "Poor" is 65 points, and "Very poor" is 55 points. Therefore, the evaluation set is V = (95, 85, 75, 65, 55). Thus, Ri can be represented as:

$$Ri=\begin{Bmatrix} D11 & D12 & D13 & D14 & D15 \\ \cdots & & & & \\ Di1 & Di2 & Di3 & Di4 & Di5 \end{Bmatrix}$$

So the evaluation results set for basic abilities is Bn = Ci × Ri, the overall evaluation set is defined

$$Rx=\begin{Bmatrix} B1 \\ B2 \\ \cdots \\ Bn \end{Bmatrix}$$

As the evaluation result set Bx = Cj × Rx. The total score is calculated as S = Bx × V = Cj × RX × V.

The application example of evaluation method

Data Collection: Zhang, a player from Ningbo University men's basketball team, is selected as the evaluation subject. As mentioned earlier, various evaluators assess the overall performance of this player. Evaluators mark a " ✓ " next to the corresponding evaluation level, assigning a specific evaluation level to each evaluation criterion. Fill in Table 5 with the test scores of Zhang's 11 performance indicators, and then refer to the Single Item Scoring Table to fill in the

corresponding scores for each physical fitness indicator. According to the assigned values for each rating level, where "Excellent" is 95 points, " Good" is 85 points, "Average" is 75 points, "Poor" is 65 points, and "Bad" is 55 points, the judgment set is formulated as: V = (95, 85, 75, 65, 55). Finally, calculate the comprehensive physical fitness final score based on the formula.

Table 4 The Zhang XX Comprehensive Evaluation Form

First-level indicators	Weight Value	Second-level indicators	Test Results	Weight Value	Score	Overall Score
Physical Test	0.6	LAT	5.1	0.052	87	85.67
		RAST	6.2	0.084	84	
		BPT	36	0.184	86	
		MJR	3.47	0.503	87	
		SRT	121.6	0.177	87	
Technical capability evaluation	0.4	TSPSOR	28.5	0.391	83	
		FGPSOR	34.5	0.229	85	
		FDI	31.6	0.190	87	
		PCDD	12.8	0.103	84	
		ICDD	15.9	0.054	86	
		HM	16.6	0.030	87	

The final score (S) of the athlete's antagonistic technical and tactical ability in Table 4 was calculated using the formula: $S = B_x \times V = C_j \times R_X \times V = (0.275, 0.712, 0.013, 0, 0) \times (95, 85, 75, 65, 55) = 85.67$. This suggests that our high-level basketball athlete from Ningbo University earns a comprehensive evaluation score of 85.67 points. Put plainly, Zhang XX, our high - level male basketball athlete from Ningbo University, secures a performance test evaluation score of 85.67 points, placing his performance in the "Good" category.

Discussion

The aim of this study was to establish a set of performance indicators for evaluating elite athletes' athletic qualities, which would serve as a crucial reference for selecting basketball players. Coaches identified 11 unique indicators, typically rating them as important to extremely important, across two different categories: physical fitness and movement skills. For most indicators, coach observation was determined as the optimal assessment method, with objective performance tests identified for all physical fitness indicators. These findings hold significant implications for developing basketball - specific test protocols for talent recruitment and monitoring player progress.

Currently, coach observation stands out as the most commonly used method for assessing players' individual performance, with almost all movement skill characteristics determined through coach observation. This aligns with findings from Butteworth, O'Donoghue and Cropley (2013) suggesting that coaching decisions often rely on intuition, feelings, events, and past experiences (Butteworth, O'Donoghue, & Cropley, 2013) rather than objective measurements. Coaches acknowledged the challenges in defining and measuring many of the identified indicators, indicating a lack of consensus on the best measurement methods (Teramoto et al., 2018). This may explain why coaches tend to make most decisions through observation. In contrast, coaches were better able to identify specific physical fitness and movement skill tests. This could be attributed to the widespread use of test protocols such as the NBA Combine (Teramoto, et al., 2018) and Basketball Australia (Pyne, et al., 2011) for assessing speed, strength, agility, muscular endurance, and flexibility.

Future research should focus on quantifying the relationship between performance indicators rated as 'important' by coaches and objective measurements. Combining objective and subjective measurements could improve talent recruitment outcomes. Researchers should also examine whether these performance indicators are meaningfully associated with game statistics. Studies could investigate whether subjective coach ratings of these performance indicators correlate with corresponding objective measurements or explore the relationship between longitudinal changes in these performance indicators and changes in basketball statistics. Additionally, future studies could explore differences in coach - identified indicators or ratings of importance across different geographical regions, competitive levels, and/or genders.

Conclusions

The athletic competence of high-level university basketball players refers to their ability to demonstrate competitiveness in basketball training or competition. The index system for assessing the athletic competence of high - level university basketball players consists of one primary indicator, namely athletic competence, and two secondary indicators, namely physical fitness and movement skills, along with corresponding 11 tertiary indicators. Through the established index system, the athletic competence of Zhang XX, a player from the Ningbo University men's basketball team, was evaluated. Using the fuzzy comprehensive evaluation method, the score and grade of Zhang XX's athletic competence were calculated, demonstrating the operability of the index system. The training of basketball players' athletic competence is a long-term process, and there are significant differences in the athletic foundation of different athletes. Therefore, coaches should adopt a phased and personalized teaching approach during training. In the training process, the weight of indicators does not necessarily reflect their importance; indicators with lower

weights often play a crucial role in competitions. Thus, the training of basketball players' athletic competence needs to be systematic, with the goal of maximizing the athletes' athletic abilities.

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Received: May 2, 2024
Revised: Octo 24, 2024
Accepted: November 7, 2024