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The special physical fitness evaluation statistics and evaluation of basketball players

Shiliang You
Shenyang Sport University, Shenyang 110102, Liaoning, (CHINA)
E-mail: zb58@163.com

ABSTRACT

In recent years physical fitness has become a study hot in various sports projects, objectively and accurately grasp the overall situation of basketball players to find "short board" of each athlete. This paper starts from the critical factor "physical fitness" that affects basketball athletic performance, studies the special physical fitness evaluation indicators and evaluation methods for college student basketball players, and establishes a more scientific and reasonable index system and mathematically statistical evaluation model. For the specific circumstances of each athlete we can develop more reasonable training programs through research, improve training efficiency and provide a theoretical basis for improving the training level and achievements of college basketball.

KEYWORDS

Special physical fitness;
Analytic hierarchy process;
Statistics and evaluation.

INTRODUCTION

Most national experts define fitness as a continuous exercise capacity in specific sports based on the athletes congenital quality and acquired training. This is a comprehensive athletic ability related to human morphological structure, function regulation and conversion and storage of material and energy, also interacted with the external environment. Scientific and rational exercise training is the most important means to improve and enhance the physical fitness.

From the point of view of system theory, college athletes' physical fitness has the characteristics of the hierarchy, is a complete system with a multi-level, multi-factor structure. The existence of this level is because there are many differences between the various elements of the system in combination ways; this difference will make the various elements of the system components show the level difference. Therefore, the core of the training process is the overall control of this complex system. In order to achieve scientific and accurate control of the whole system, it is necessary to achieve depth and detailed analysis of the structure and function within the system, so as to form a thorough understanding of the inherent laws of the physical fitness system for college students. Therefore, for the study of the physical fitness structure of the college basketball players, it can also be seen as a multi-level system. The first layer includes body shape, sport quality and physiological function three subsystems, each subsystem below contains multiple subsystems; layers composition eventually constitute a complex network system that

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reflects the College Basketball Players' Physical Fitness.

This paper studies the special physical fitness evaluation indicators and evaluation methods for college student basketball players, establishes a more scientific and reasonable index system, strives to accurately and objectively evaluate fitness level of college student basketball players, and provides theoretical support for the college basketball training.

EVALUATION INDEX SYSTEM

The fundamental purpose of special physical fitness evaluation on college student basketball players is to timely, accurately, systematically and effectively grasp their physical fitness condition. With the increasingly scientific sports training, control theory, system theory, information theory, and other more theory are combined to exercise training, which are meant to achieve modeling and quantitative optimal control of the entire training process. This process is based on the status of the athlete, combined with status characteristics of elite athletes, and realized through corresponding control model.

As for the determination of the subject's evaluation index, the first-level indicators are identified as body shape, physiological function and sports quality. Then we carry out two rounds of screening using Delphi method by a large number of questionnaire surveys. The object of questionnaire investigation are the provincial sports teams, the Sports Institute and many colleges, including 10 national coaches, 15provincial coaches, 23 professors, 30 associate professors, and many teachers, coaches with intermediate professional title or above who have long been engaged in basketball teaching and training. The first round of the index questionnaire includes 48 indicators like height, hand length, wingspan, the ankle circumference, body fat percentage, Quetelet index, reaction time, half triangle run, 100m run, 10 * 15 m shuttle run, the run-up touching height, barbell squat and hemoglobin content, including the most complete indexes that may affect the physical indicators of college basketball players as much as possible. After the first round of the survey, keep the indexes that expert recognition degree is more than 70% and make proper adjustments untill24 indexes, proceed to the second round of the survey. Keep the indexes that expert recognition degree is more than 80% in the second round, and then adjustment re-based on the independence, interoperability and testability principles of the indexes, and ultimately get the index system, as shown in TABLE 1:

TABLE 1 : Evaluation system of physical fitness for college basketball athletes

Target *A*	First layer index *B*	Secondary index *C*
Evaluation system of physical fitness for college basketball athletes	Body shape B1	Shank length C1 Biceps circumference difference C2 Body fat rate C3
	Sport quality B2	Half triangle run C4 1 minute vertical and horizontal bracing C5 Run-up touching height C6 10*15m shuttle run C7 Shuffling 3m*5 round-trip C8
	Physiology function B3	Vital capacity/weight C9 Maximal oxygen uptake C10

THE DETERMINATION OF THE INDEX WEIGHTS

Commonly used determination method of the index weights has the principal component analysis, matrix algorithms, mean method and analytic hierarchy process method. This paper uses TL Sadie analytic hierarchy process. Because the implementation process of this approach is through in-depth analysis of complex systems to identify certain elements or indicators of the affected system, divide them into a plurality of groups according to their different properties, form a hierarchical structure, then through the comparison of each other determine the relative importance of the elements in the various levels, thereby construct the hierarchical model and carry through analysis and decision of the system or problem. This process well reflect the guiding

ideology that this paper uses system theory method to research and evaluate College Basketball Players physical problem.

The index weight calculation of Analytic Hierarchy Process (AHP) has a variety of different scales; this paper used the classic 1 to 9 and its reciprocal scale method (TABLE 2).

TABLE 2 : 1 to 9 scale method of AHP model

Importance scale a_{ij}	Degree of relative importance
1	Equally important
3	Slightly important
5	Basically important
7	Really important
9	Absolutely important
2,4,6,8	Median of two contiguous importance degree
Reciprocal	$a_{ji}=\frac{1}{a_{ij}}$

Use a_{ij} to represent the relative importance degree of the chosen two elements, construct the relative importance judgment matrix A of each index to express the comparison result of each group.

$$A=\begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{bmatrix} \quad (1)$$

Wherein: $a_{ij}>0$, $a_{ii}=1$.

In order to ensure the validity of the judgment matrix, you also need test consistency. The usual inspection method is using CR value, i.e., random consistency ratio. The formula is as follows:

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

$$\lambda_{\max}=\frac{1}{n}\sum_{i=1}^{n}\frac{(AW)_i}{w_i} \quad (3)$$

$$CR=\frac{CI}{RI} \quad (4)$$

Where CI is the general consistency index, RI is average random consistency index. When the order is different, its value is shown in TABLE 3. $\lambda_{\max}$ is the eigenvalue maximum of the judgment matrix. When the calculated CR value is smaller, indicating the judgment matrix is more effective, the usual standard is $CR\le 0.1$. On the contrary, if the value of CR is too large, you need to adjust the judgment matrix.

TABLE 3 : The value of RI under different orders

Order	1	2	3	4	5	6	7	8	9
RI	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45

Using the effective judgment matrix A obtained above, you can find the index weight of index layer B, and these weights constitute the importance degree of each index in layer B. Similarly, we can obtain the index weight of layer B to index layer C. Finally, find the comprehensive weight of layer B and layer C to the target layer. The commonly used calculation methods have mean method and square root method. We use the square root method. Conduct quadrature to the row elements in the judgment matrix, and then seek the power of $1/n$:

$$w_i=\left(\prod_{j=1}^{n}c_{ij}\right)^{1/n},(i,j=1,2,\ldots,n) \quad (5)$$

Rerunning normalization processing, get weighting coefficient:

$$W_i=\frac{w_i}{\sum_{i=1}^{n}w_i} \quad (6)$$

Weight vector $W=(W_1,W_2,\ldots,W_n)^T$

Through the statistical analysis of expert opinion obtained by the questionnaire, we can obtain the judgment matrix from first layer index to target layer and from secondary index to first layer index in the index system:

$$A=\begin{pmatrix} 1 & 1/2 & 2 \\ 2 & 1 & 2 \\ 1/2 & 1/2 & 1 \end{pmatrix} \quad B_1=\begin{pmatrix} 1 & 2 & 3 \\ 1/2 & 1 & 2 \\ 1/3 & 1/2 & 1 \end{pmatrix} \quad B_2=\begin{pmatrix} 1 & 1/2 & 3 & 2 & 4 \\ 1/3 & 1 & 3 & 2 & 4 \\ 1/2 & 1/3 & 1 & 1/2 & 3 \\ 1/2 & 1/2 & 2 & 1 & 4 \\ 1/4 & 1/4 & 1/3 & 1/4 & 1 \end{pmatrix}$$

$$B_3=\begin{pmatrix} 1 & 1/2 \\ 2 & 1 \end{pmatrix}$$

The first layer index weight vector $W=(0.31,0.49,0.20)^T$

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and the secondary index weight vector $W_1 = (0.54, 0.30, 0.16)^T$ $W_2 = (0.24, 0.16, 0.18, 0.20, 0.12)^T$ $W_3 = (0.33, 0.67)^T$ can be determined.

Then verify the consistency of individual judgment matrix:

$$AW = \begin{pmatrix} 1 & 1/2 & 2 \\ 2 & 1 & 2 \\ 1/2 & 1/2 & 1 \end{pmatrix} \begin{pmatrix} 0.31 \\ 0.49 \\ 0.20 \end{pmatrix} = \begin{pmatrix} 0.955 \\ 1.510 \\ 0.600 \end{pmatrix}$$

$$B_1W_1 = \begin{pmatrix} 1 & 2 & 3 \\ 1/2 & 1 & 2 \\ 1/3 & 1/2 & 1 \end{pmatrix} \begin{pmatrix} 0.54 \\ 0.30 \\ 0.16 \end{pmatrix} = \begin{pmatrix} 1.620 \\ 0.890 \\ 0.490 \end{pmatrix}$$

$$B_2W_2 = \begin{pmatrix} 1 & 1/2 & 3 & 2 & 4 \\ 1/3 & 1 & 3 & 2 & 4 \\ 1/2 & 1/3 & 1 & 1/2 & 3 \\ 1/2 & 1/2 & 2 & 1 & 4 \\ 1/4 & 1/4 & 1/3 & 1/4 & 1 \end{pmatrix} \begin{pmatrix} 0.24 \\ 0.16 \\ 0.18 \\ 0.20 \\ 0.12 \end{pmatrix} = \begin{pmatrix} 1.740 \\ 1.660 \\ 0.813 \\ 1.240 \\ 0.330 \end{pmatrix}$$

$$B_3W_3 = \begin{pmatrix} 1 & 1/2 \\ 2 & 1 \end{pmatrix} \begin{pmatrix} 0.33 \\ 0.67 \end{pmatrix} = \begin{pmatrix} 0.665 \\ 1.330 \end{pmatrix}$$

$$\lambda_{A\max} = \frac{1}{n}\sum_{i=1}^{n}\frac{(AW)_i}{w_i} = \frac{1}{3}\left(\frac{0.955}{0.31} + \frac{1.510}{0.49} + \frac{0.600}{0.20}\right) = 3.054$$

Similarly available:

$\lambda_{B_1\max} = 3.010$, $\lambda_{B_2\max} = 5.218$, $\lambda_{B_3\max} = 2.000$,

$$CI_A = \frac{\lambda_{\max} - n}{n-1} = \frac{3.054 - 3}{2} = 0.027$$

Similarly available:

$CI_{B_1} = 0.005$, $CI_{B_2} = 0.0545$, $CI_{B_3} = 0$,

$CR_A = \frac{CI}{RI} = \frac{0.027}{0.58} = 0.046$, $CR_{B_1} = 0.009$, $CR_{B_2} = 0.049$, $CR_{B_3} = 0$

Random consistency ratio of the judgment matrix is <0.1, indicating that the individual judgment matrix are in good agreement. It can be used to build the Physical Fitness Evaluation Model of Basketball Players'.

Using the eigenvectors and eigenvalues of judgment matrix obtained above, we can obtain the local weights of 10 secondary indicators. Then conduct quadrature with local weights of higher level indicators, global weight can be obtained shown in TABLE 4 below:

TABLE 4 : Evaluation Index Weight

Target *A*	First layer index *B*	*Weight* w_i	Secondary index *C*	*Weight* w_{ij}	*Comprehensive weight* w_j
Evaluation system of physical fitness for college basketball athletes	Body shape B1	0.31	Shank length C1	0.54	0.167
			Biceps circumference difference C2	0.30	0.093
			Body fat rate C3	0.16	0.050
	Sport quality B2	0.49	Half triangle run C4	0.24	0.118
			1 minute vertical and horizontal bracing C5	0.26	0.127
			Run-up touching height C6	0.18	0.088
			10*15m shuttle run C7	0.20	0.098
			Shuffling 3m*5 round-trip C8	0.12	0.059
	Physiology function B3	0.20	Vital capacity/weight C9	0.33	0.066
			Maximal oxygen uptake C10	0.67	0.134

EVALUATION SYSTEM OF PHYSICAL FITNESS FOR COLLEGE BASKETBALL ATHLETES

In order to objectively and quantitatively compare the physical agility differences between college student basketball players and reveal the laws that affect the athletes' physical fitness, you need to develop a unified comparison standard. We take 120 athletes from 10 students' basketball teams of many universities and use effective testing tools to test the above indicators and obtain the maximum value, minimum value, mean value sand standard deviation of each index. And then use equation (7) to standardize the original data of the will to be evaluated sample:

$$x_{ij}' = (x_{ij} - x_j)/s_j \quad (7)$$

Wherein the average value of the j-th index is x_j, s_j is the standard deviation of the j-th index, x_{ij}' is the

standardized results of the j-th index value for i-th sample.

Use extreme standardized formula; express the data after standardization as a 100-point score:

$$x_{ij} = \frac{x_{ij}' - x_{j\min}'}{x_{j\max}' - x_{j\min}'} \times 100 \quad (8)$$

In the formula: $x_{j\min}'$ and $x_{j\max}'$, respectively represent the minimum and maximum values of $x_{1j}', x_{2j}', \ldots, x_{fj}'$; Obtained x_{ij} is the percentile score after processing of the j-th indicator for the i-th sample.

The indicators data processing results of our university men's basketball team's 12 players using the method described above are shown in TABLE 5 below:

According to the data in TABLE 5 and index weights, carry through weighted sum, and the first level index score and special physical value of each player

TABLE 5 : The indicators data processing results of the 12 players

No.	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
1	64.3	76.1	53.1	78.2	85.6	74.2	67.0	78.2	85.4	79.1
2	52.4	77.0	51.8	65.9	80.4	73.5	65.2	75.2	78.3	67.5
3	81.9	60.3	80.1	72.7	50.4	74.7	41.4	28.8	84.6	25.2
4	73.9	75.8	52.4	85.6	73.8	64.1	72.0	67.5	44.9	74.7
5	45.0	16.5	28.4	37.4	47.7	32.2	53.8	67.3	59.3	57.5
6	50.4	79.2	66.6	72.9	55.8	74.7	81.9	85.5	87.3	81.0
7	87.5	88.8	91.3	79.4	82.3	89.4	93.8	83.7	68.4	97.4
8	91.1	90.1	86.4	79.2	87.3	92.9	94.7	80.3	95.9	98.5
9	66.6	67.5	78.3	85.5	79.2	67.5	64.8	69.3	58.3	50.2
10	64.8	85.7	79.2	85.5	89.4	87.6	73.8	79.2	62.1	64.9
11	75.2	60.0	52.0	29.6	28.0	34.4	18.0	7.6	63.2	47.2
12	70.4	66.4	15.2	66.4	75.6	73.6	89.2	72.8	75.2	71.2

can be expressed as:

$$B_{ik} = \sum_{j=1}^{n_k} x_{ij} w_{ij} \quad (9)$$

$$A_I = \sum_{i=1}^{n} x_{ij} w_j \quad (10)$$

Wherein B_{ik} represents the $(k = 1,2,3)$-th first layer index score of the i-th player's; w_{ij} represents the j-th secondary index weight under the i-th first-level index; A_I represents special physical fitness score of the players; x_{ij} $(0 \le x_{ij} \le 1)$indicates a 100-point scale score of the j-th index of the i-th samples; w_j is the comprehensive weight of the j-th index. After calculating a score, we can conduct level evaluation on the players' indexes and special physical qualities according to the level evaluation criteria in TABLE 6.

TABLE 6 : Classification standard of evaluation level

index	Poor	Lower	Medium	Good	Excellent
Body shape B1	0-15	15-30	30-50	50-80	80-100
Sport quality B2	0-35	35-50	50-70	70-90	90-100
Physiology function B3	0-25	25-50	50-75	75-90	90-100
Special physical fitness A	0-20	20-45	45-70	70-85	85-100

TABLE 7 : Special physical fitness evaluation results

No.	1	2	3	4	5	6	7	8	9	10	11	12
Body shape	66.1	59.7	75.1	71.0	33.8	61.6	88.5	90.1	68.7	73.4	66.9	60.4
Evaluation level	Good	Good	Good	Good	Medium	Good	Excellent	Excellent	Good	Good	Good	Good
Sport quality	77.2	72.01	55.7	73.8	46.0	72.1	85.4	87.0	74.5	83.8	25.1	75.4
Evaluation level	Good	Good	Medium	Good	Lower	Good	Good	Good	Good	Good	Poor	Good
Physiology function	81.2	71.1	44.8	64.9	58.1	83.1	87.8	97.6	52.9	64.0	52.5	72.5
Evaluation level	Good	Medium	Lower	Medium	Medium	Good	Good	Excellent	Medium	Medium	Medium	Medium
Special physical fitness	74.5	68.0	59.6	71.1	44.6	71.0	86.8	90.1	68.4	76.6	43.5	70.2
Evaluation level	Good	Medium	Medium	Good	Lower	Good	Excellent	Excellent	Medium	Good	Lower	Good

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The corresponding rating calculated by each team member's physical evaluation results are shown in TABLE 7:

CONCLUSIONS

The special physical evaluation model established in this paper can conduct accurate, objective and comprehensive evaluation on college basketball players. The evaluation results have both the quantitative results and the qualitative results. Meanwhile acquiring the special physical evaluation, we also get the three first layer index evaluation results of the physical condition, sports quality and physiology functions. This helps us to find each athlete's "shortcomings" in the grasp of the overall situation, and then we can develop more reasonable training programs to improve training efficiency due to the specific circumstances of each player. Compared to the actual performance of the sample athletes, the evaluation results of the model is scientific and rational, can truly reflects their physical condition. The study result of this paper provides important ideas for the development of China Basketball Training Theory System, and has high application value.

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