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The factor analysis of chinese and foreign aerobics athlete's shape quality differences based on regression equation

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ABSTRACT

This article focuses on the regression analysis of aerobics athlete's shape quality with different ages. First, based on the theory of factor analysis it studies the body shape index of juvenile aerobics athlete, obtains three most representative shape indicators: the length and girth factor, component factor and width factor, and provides objective and scientific basis for the selection of good seed, training, and monitors of athletic aerobics. In the study taking the stepwise regression analysis as the theoretical basis, it studies the body shape and physical indicators of excellent adult aerobics athletes, and provides objective and theoretical basis for the coaches in the advanced talent selection and scientific training.

KEYWORDS

Shape qualities;
Regression equation;
Factor analysis;
Aerobics.

INTRODUCTION

At present, China aerobics strength still has a certain gap with world top teams. This shows that the long-term development of aerobics can't do without the support of scientific training theories. Competitive aerobics belongs to the project technique-leading expressing difficult and beauty, where skill and physical agility have a high integration, which needs express complex motor skills and achieve aesthetic appeal within the prescribed time by continuous high strength. Athlete's body shape and physical quality occupy leading position in the game, so the body shape and a physical quality indicator of aerobics athlete becomes an important indicator for talent selection and scientific training.

This paper starts from the study on the shape quality of athletes in different stages, first does a detailed study of juvenile aerobics athlete's body shape indexes based on factor analysis, provides objective and scientific basis for the selection of good seed, training, and monitors of athletic aerobics, and sums up the most representative specific indicators of body shape. Secondly, based on stepwise regression analysis theory do a detailed study on the body shape and physical quality indicators of adult aerobics athlete, and provides objective and theoretical basis for the coaches in the advanced talent selection and scientific training.

STEPWISE REGRESSION ANALYSIS

In practical problems, people always want to select some variables from the many variables affecting the dependent variable y as independent variables, use multivariate regression analysis to establish the "opti-

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mal" regression equation and predict or control the dependent variable y. The so-called "optimal" regression equation means containing the regression equation of independent variables that have significant effects on the dependent variable y and not containing the regression equation of independent variables that have no significant effects on the dependent variable y. Stepwise regression analysis is a regression analysis put forward based on such principles. The implementation process of stepwise regression analysis is that in every step to calculate the partial regression sum of squares (i.e. contribution rate) for the variable has been introduced to the regression equation, and then select a variable with the least partial regression sum of squares, conduct significance test for a given level, if the variable is significant it does not have to be removed from the regression equation. Then several other variables in the equation do not need to be excluded (because the partial regression sum of squares several of other variables are greater than the smallest one even do not need to be excluded). Conversely, if not significant, the variable needs to be removed, and inspect other variables in the equation according to the ascending sequence of partial regression sum of squares. Remove all the variables that have no significant effect and reserve the significant ones. Then calculate the partial regression sum of squares of the variables not introduced into the regression equation and choose one variable with the largest partial regression sum of squares. Similarly at a given level conduct significant test, if significant then introduce the variable into the regression equation. This process continues indefinitely until a variable in the regression equation cannot be excluded and no new variables can be introduced, whereupon stepwise regression process ends. At this point the obtained equation is the "optimal" regression equation. The features of stepwise regression analysis: two-way selection, namely the introduction of meaningful variables (forward method), excluding insignificant variables (backward method). Its main calculation is as follows:

(1) Determine the F-test values. Before the stepwise regression calculation one need to determine whether each variable has a significant F-test levels, in order to be as the standard to introduce or remove variables. F-test level is to be determined according to the specific situation of the actual question.

(2) Stepwise calculations. Each step of stepwise calculation always first considers excluding variable, considering the introduction of variables only when there is no excluding variable. In actual calculation, the beginning steps may have been introduced variables, the subsequent steps may also successively removed a number of variables. When there is no variables that can be removed in the equation, and no variable can be introduced into the equations, then the second stage stepwise calculation come to an end, and transfers to the third stage.

(3) Other calculations, mainly calculate the selected variables coefficients the multiple correlation coefficient residual and other statistics of the regression equation.

Calculation process is shown in Figure 1.

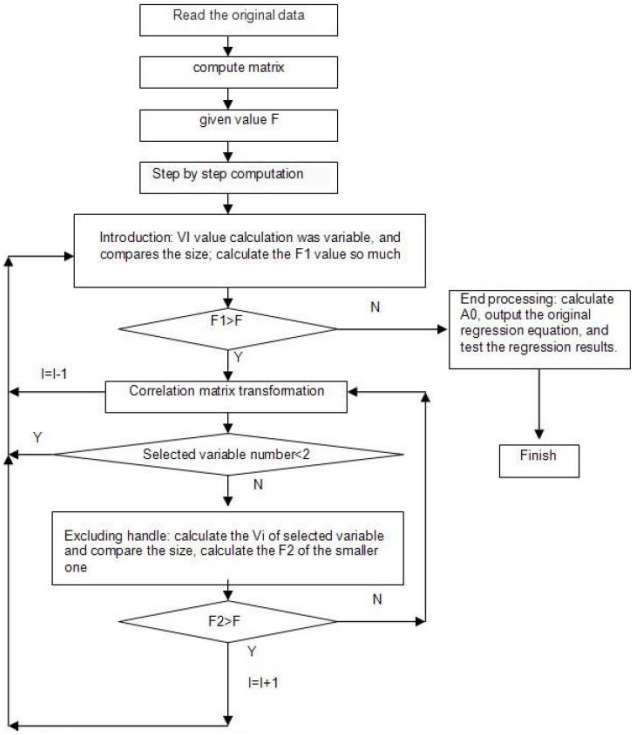

Figure 1 : Stepwise regression analysis processes

FACTOR ANALYSIS

There are two core problems of factor analysis: First, how to construct factor variables; second, how to do named explanation on factor variables. Therefore, the basic steps and solving idea of factor analysis is to focus on these two core issues. Factor analysis

often has the following four basic steps: (1) Confirm whether the original variables to be analyzed are suitable for factor analysis. (2) Construct factor variables. (3) Use the rotation method to make factor variables more interpretable. (4) Calculate the score of factor variables.

Factor analysis is calculated as follows: (1) Standardize the original data to eliminate the difference of variables on the order of magnitude and dimensions. (2) Seek the correlation matrix of standardized data. (3) Seek the eigenvalues and eigenvectors of correlation matrix. (4) Calculate the variance contribution rate and the cumulative variance contribution rate. (5) Determining factor: suppose $F_1, F_2, \cdots, F_p$ is p factors, the data information amount (i.e., the cumulative contribution rate) that the first m factors contained is not less than 80%, take the former m factors to reflect original evaluation factors. (6) Factor rotation: If the m factors cannot be determined or the actual meaning is not obvious, then need to rotate the factor to obtain a more obvious practical meaning. (7) Use a linear combination of the original indicators to seek the factor scores: Use regression estimation, Bartlett estimation method or the Thomson to estimate factor scores. (8) Composite score: Take the variance contribution of each factor as weight, obtain the comprehensive evaluation index function $F = \frac{w_1F_1 + w_2F_2 + \cdots + w_mF_m}{w_1 + w_2 + \cdots + w_m}$ by the linear combination of each factor, where w_i is the factor variance contribution rate before rotation or after rotation. (9) Score sorting: Score ranking can be obtained using the composite score.

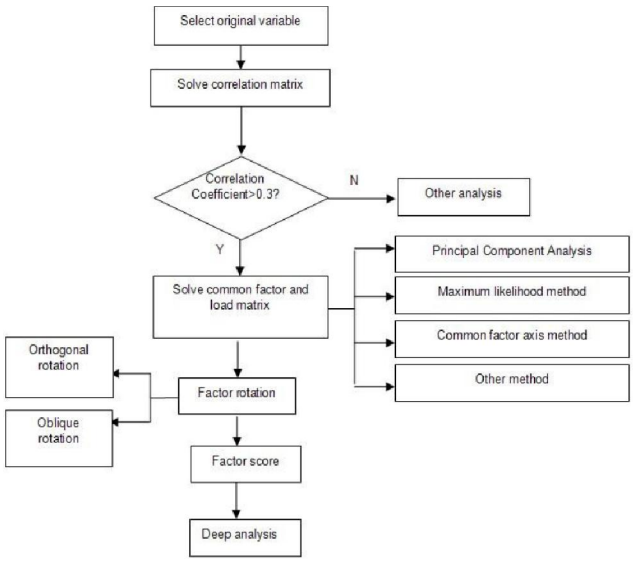

Figure 2 : Factor analysis flowchart

The specific flow chart is shown in Figure 2.

THE BODY SHAPE FACTOR ANALYSIS OF JUNIOR AEROBICS ATHLETE

This article first screens out 12 shape indexes: height (S1), upper limb length (S2), sitting height (S3), weight (S4), bust (S5), hips circumference (S6), calf circumference (S7), pelvic width (S8), iliac sebum (S9), scapular sebum (S10), the upper arm sebum (S11), shoulders width (S12). In these indicators, based on factor analysis and no loss or less loss of original information principle, transform the original number of original interrelated factors into a composite indicator that a few is independent of each other and can comprehensively reflect the original information, which is a multi-factor statistical methods. Take the measured data of a session of the National Aerobics Championship in recent years as indicators to study the body shape data (see TABLE 1).

TABLE 1 : Body shape indicator data

Indicator	Sample size	Minimum value	Maximum value	Mean value	Standard deviation
S1	70	1.27	1.73	1.464	9.199E-02
S2	70	49	70.8	58.68	4.62
S3	70	65.5	89.5	74.59	4.81
S4	70	22	58	35.52	7.18
S6	70	60	88	73.21	6.57
S5	70	57	81	66.53	5.57
S8	70	19	29.1	23.42	2.12
S7	70	23	35	28.86	2.73
S9	70	4	20	8.81	3.47
S10	70	4	17.5	8.94	3.1
S12	70	21.2	39.2	27.79	2.79
S11	70	5	23	12.13	4.16

Then calculate the correlation coefficient between the 12 indicators, if the correlation coefficient is closer to 1, indicating the correlation degree between the two indicators is higher, and the results is shown in TABLE 2.

Then calculate the eigenvalues of the correlation coefficient matrix, the contribution rate of the common

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factor and the cumulative contribution rate between the 12 indicators, and the results are shown in TABLE 3.

TABLE 2 : Correlation coefficient

Indicator	S1	S2	S3	S4	S6	S5	S8	S7	S9	S10	S12	S11
S1	1	0.916	0.883	0.879	0.849	0.822	0.101	0.785	0.36	0.467	0.101	0.369
S2	0.916	1	0.799	0.82	0.785	0.758	0.746	0.73	0.269	0.378	0.126	0.337
S3	0.883	0.799	1	0.903	0.878	0.871	0.82	0.841	0.436	0.526	0.171	0.408
S4	0.879	0.82	0.903	1	0.937	0.944	0.824	0.887	0.527	0.627	0.145	0.559
S6	0.849	0.785	0.878	0.937	1	0.902	0.869	0.879	0.577	0.679	0.199	0.585
S5	0.822	0.758	0.871	0.944	0.902	1	0.786	0.859	0.495	0.611	0.149	0.49
S8	0.803	0.746	0.82	0.824	0.869	0.786	1	0.765	0.456	0.594	0.232	0.456
S7	0.785	0.73	0.841	0.887	0.879	0.859	0.765	1	0.521	0.621	0.235	0.511
S9	0.36	0.269	0.436	0.527	0.577	0.495	0.456	0.521	1	0.733	0.004	0.604
S10	0.467	0.378	0.526	0.627	0.679	0.611	0.594	0.621	0.733	1	0.245	0.676
S12	0.101	0.126	0.171	0.145	0.199	0.149	0.232	0.235	0.004	0.245	1	0.1
S11	0.369	0.337	0.408	0.559	0.585	0.49	0.456	0.511	0.604	0.676	0.1	1

TABLE 3 : Eigenvalues, the contribution rate of common factor and cumulative contribution rate

Factor	eigenvalues	contribution rate	cumulative contribution rate
1	11.62	64.53	64.53
2	1.58	8.77	73.3
3	1.21	6.72	80.02
4	0.56	3.1	86.97
5	0.69	3.86	83.87
6	0.37	2.03	93.14
7	0.45	2.48	91.48

TABLE 3 shows the eigenvalues greater than 1 are the first three factors, so we take the first three factors as main factors. Finally, based on factor analysis theory, use factor rotation method to calculate the factor loading matrix (see TABLE 4), obtain that three main factors are the length and girth factor, component factor and width factors. Wherein the length and girth factor means: height, sitting height, weight, arm length, calf circumference, chest circumference, hip circumference and pelvis width; component factor refers to iliac sebum, scapular sebum and upper arm sebum; width factor refers to the width of the shoulder.

THE BODY SHAPE FACTOR ANALYSIS OF ADULT AEROBICS ATHLETE

Physical body shape is the material basis of physical agility, is the external and internal morphological characteristics of the body. Aerobics is the project express difficult and beauty; beautiful shape is a necessary requirement for the project. Indicators reflecting the physical characteristics of external morphology have: height (height, sitting height, arch height), length (lower limb length, arm length, head length, neck length, etc.), circumference (chest, arm circumference, waist circumference, leg circumference, etc.), width (head width, shoulder width, hip width) and plumpness (weight, skinfold thickness, etc.); Indicators reflecting internal morphology include heart vertical and horizontal diameter, muscle shape, cross-section and so on. Physical fitness is a core part of the physical agility system architecture. Physical quality indicators cover racers special strength, endurance, flexibility, coordination, speed, etc. and other different physical aspects' information, and present the athletes' overall ability development level hierarchically and structurally in a interrelation and replenish relationship.

TABLE 4 : Factor loading matrix

Indicator	The first main factor	The second main factor	The third main factor
S1	0.934	0.12	-9.56E-02
S2	0.91	3.49E-02	-4.36E-0
S3	0.91	0.22	4.35E-03
S4	0.89	0.38	-1.16E-02
S6	0.86	0.44	5.53E-02
S5	0.87	0.36	1.96E-03
S8	0.82	0.31	0.11
S7	0.83	0.39	9.7E-02
S9	0.24	0.83	-0.1
S10	0.36	0.82	0.14
S12	0.14	0.12	0.89
S11	0.26	0.8	-1.96E-02

After several tests and reliability tests, the paper selected the following morphological indicators: height, weight, shoulder width, arm length, leg length (S13), hip circumference, upper arm circumference (S14), thigh circumference (S15) and bust circumference; quality indexes: 50 m run, standing long jump, ribs and abdomen leg raise, and chin-up. The selected data involved in this paper is the test data of the outstanding athletes gaining excellent achievements in the domestic games in recent years. First, this paper analyzes the morpho-

logical indexes that have a significant influence on athletic performance, select morphological index data of two groups of athletes, the analysis results are in TABLE 5.

TABLE 5 : The relationship of shape index and sports performance

Indicators	Athletes group 1	Athletes group 2	Significant test
S5	0.48	0.39	0.21
S4	-0.06	-0.28	0.45
S12	0.43	0.4	0.28
S2	0.24	0.51	0.52
S13	0.25	0.15	0.45
S6	0.65	0.59	0.55
S14	0.79	0.65	0.38
S15	0.08	0.005	0.14

TABLE 5 shows, upper arm circumference, arm length, weight and bust have reached the size of a significant level for the correlation degree of athletic performance. According to the World Aerobics Championship data in recent years, this paper conduct contrastively analysis on shape indexes of the world's top athletes and Chinese college athletes, and the results are shown in TABLE 6.

TABLE 6 : Comparative analysis of shape indexes

Athlete	S1	S4	S15	S14
World top athletes	1.79	35~37	52~53	27~30
Chinese athlete 1	1.75	37.5	52.8	29.4
Chinese athlete 2	1.71	38.1	53.5	28.5
Chinese athlete 3	1.73	38.2	53.8	28.9
Significant test	<0.05	>0.05	>0.05	<0.05

TABLE 6 shows there is a gap between Chinese athletes and the world elite athletes in several shape indexes having a higher correlation with athletic performance. Absolute low height is one of the main factors of gap, which is also one of the main factors affecting performance.

The following article analyzes on the quality indicators that have a significant influence on athletic performance. Select the quality indicator data of twelve members in the two groups of athletes, the analysis results are shown in TABLE 7.

Seen from TABLE 7, standing long jump, ribs and abdomen leg raise and chin-ups have higher degree of correlation on sports scores. Similarly, the paper contrastively compares the quality indicators of the world's top athletes and Chinese athletes, and the results are shown in TABLE 8.

TABLE 8 shows several quality indicators have a high correlation with athletic performance, there is a gap between Chinese athletes and the world elite athletes. The overall gap of Chinese athletes and the world elite athletes in the special strength and coordination is not big, but Chinese athletes have significant gaps with the world elite athletes in terms of speed and jumping.

Through test data of body shape and physical fitness, calculate the correlation coefficient with performances, on the basis of a multivariate analysis, conduct stepwise regression analysis and screen out the body shape and physical quality indicators that affect performance, establish multiple regression equation and carry through significant test. According to the stepwise regression analysis theory, this paper establishes the regression equation:

TABLE 7 : The relationship of quality indicators and sports performance

Indicator	50 meters run	Standing long jump	Ribs and abdomen leg raise	chin-up
Correlation coefficient	0.42	0.32	-0.42	-0.43
Multiple correlation coefficient	0.48	0.63	0.57	0.5
T value	0.16	0.31	1.17	0.28

TABLE 8 : Comparative analysis of quality indicators

Athletes	50 meters run	Standing long jump	Ribs and abdomen leg raise	chin-up
World top athletes	5 seconds 8	2.98~3.06	26~28	28~30
Chinese athlete 1	6 seconds 3	2.77	22	23
Chinese athlete 2	6 seconds	2.94	22	24
Chinese athlete 3	6 seconds4	2.8	21	25
Significant test	>0.01	>0.01	<0.01	<0.01

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$$y = 2.41 + 0.599x_1 - 0.013x_4 - 0.24x_7 + 0.072x_9$$

Wherein x_1 is the height, x_4 is the arm length, x_7 is the chin-up, x_9 is the standing long jump, and $R = 0.913, sy = 0.053, f_1 = 38.04$. Seen through the multiple correlation coefficients R, the linear relationship between the dependent variable and the independent variables in regression equation is very close. Standard error estimates sy also described herein that the regression equations established in this paper have relatively high prediction accuracy.

CONCLUSIONS

This paper studied the shape indicators of the juvenile aerobics athlete with factor analysis method, and drew three main factors (length and girth factor, component factors and width factor). In addition, it studied the shape indicators of the adult aerobics athlete through stepwise regression analysis theory, did significant research with athletic performance, and obtained the body shape indicators and physical quality indicators that have a higher correlation with the performance. Meanwhile on this basis, it conducted comparison analysis with the world elite aerobics athletes, obtain that there is a gap between the Chinese athletes and the world elite athletes in terms of body shape; the results show that the gap is small in the height, stature and upper arm circumference, the gap is great in the speed and jumping ability of the quality aspects.

In summary, the shape factor is not easy to change, then in the China's outstanding aerobics athlete talent selecting must be strictly controlled and pay attention to scientific, thus reducing the gap with the world-class athletes. But physical fitness is the ability acquired through training, so in the peacetime training, coaches should focus on improving the speed and bounce of Chinese athletes, thus power and coordination is capable of long-term development.

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