ISSN : 0974 - 7435 Volume 10 Issue 2

BioTechnology
An Indian Journal

FULL PAPER

BTAIJ, 10(2), 2014 [183-191]

LALA gym special quality feature research based on factor analysis

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ABSTRACT

LALA gym is a kind of performing sports accompanying with music, it not only gathers aerobics motion and group exercise cooperation, but also gathers sports apparatus cooperation, therefore the event perfect operation needs athletes have comprehensive sports quality. This paper explores LALA gym comprehensive quality, it get the event athletes' special sports quality indicators by investigation, in order to further explore each kind sports quality indicator importance and their mutual relationships, it adopts factor analysis, and gets gathered eight sports qualities' three common factors, which provides research methods for LALA gym teaching and analyzing. Finally, it gets integrated eight kinds of special sports qualities' three items' principal component sports qualities, combining with LALA gym actual features, it analyzes three principal components, and sports quality is main factor that reflects sports features.

KEYWORDS

Factor analysis;
Special quality;
Principal component analysis;
Bartlett's test of sphericity;
KMO measurement.

INTRODUCTION

LALA gym has been introduce to China in 2000, our athletes have been firstly joined in LALA gym world competition in 2007 and gained the fifth group such good result at first try, which not only reflects LALA gym has survival soil in China, but also reflects that our country such event levels have already reached the world level. To better promote LALA gym such sports event, this paper analyzes from the athletes' required special qualities, in the hope of exploring the event features and athletes pursuit direction.

For LALA gym researches, lots of scholar have made efforts, just by their efforts, LALA gym sports levels are promoted, from which He Yun etc. (2008) By comparative analysis of LALA gym and aerobics competition rule scoring factors, it mentioned the differences that LALA gym in action completion, movement arrangement, artistic expression and gross impressions as well as other aspects from aerobics competition rules scoring factors, which provided theoretical basis for mass teachers and students positively join in LALA gym training [1]; Tian Ling etc.(2012) Taken newly released "National competition rules in 2010 to 2013"(version four) as chief researching source, made comparison with "International all stars cheerleading competition scoring rules in 2006 to 2009", by analyzing new rules' LALA gym competition winning factors, it provided guidance for our country cheerleading training and competition[2]; Yan Hong etc.(2013)during summarizing LALA gym training features and Sichuan province university LALA gym training status investigation, made analysis of the province LALA gym training advantageous factors, abandon proposed the province

university LALA gym sports level improvement method[3].

This paper, on the basis of previous research, it extracts eight special sports quality indicators that affect LALA gym sports levels, and applies experiment grouping method to explore indicator selection rationality, and utilizes factor analysis to further summarize principal component factors that affect the event sports levels, and analyzes principal factors rationality based on that.

RESEARCH OBJECTS AND RESEARCH METHODS

Research objects

Research objects are divided into contrast group and experimental group, two group members are respectively composed of 20 students, from which each group members have 10 men and 10 women.

Experimental group members are selected from one sports institution excellent skilled LALA gym athletes, their average age is 21 years old, the team is qualified to join world cheerleading championships on behalf of country; contrast group members are composed of one academy excellent skilled LALA gym players, the group members average age is also 21 years old, and they own qualification of undertaking school level large-scale sports meeting opening ceremony cheerleading.

Research methods

Document literature: Search CNKI regarding LALA gym sports ability aspect periodic documents, extract elements with regard to skilled LALA gym sports function aspects from them, and provides theoretical basis for this paper research objects' experiment designing and experiment data extracting;

Questionnaire survey: Release in the form of questionnaire to LALA gym coaches and relative judges, and objective gets sports indicators data correlated to LALA gym athletes special quality, it provides experiential basis for athletes required essential special quality indicators;

Experiment test: For questionnaire survey gaining LALA gym athletes' essential quality indicators, make corresponding indicator data testing, special quality indicators that need to test are (Index1—number of push up), (Index2—frontal balance time), (Index 3—Standing high area bend forward), (Index 4-rope skipping times per minute), (Index 5—15s/constant grand kick numbers), (Index 6—hanging leg raise time), (Index 7—15s straddle jump times) and (Index 8—lateral front split) total 8 indicators.

Mathematical statistics: Carry out descriptive statistics, deduction statistics and factor analysis on data got from sorting, then according to experimental group and contrast group statistical result to do comparative analysis.

LALA GYM ATHLETES' ESSENTIAL SPECIAL QUALITY INDICATORS ANALYSIS

According to "National LALA gym competition rules in 2010 to 2013"regulations, it is clear that skilled LALA gym sets motions should appear four kinds of difficulty motions as following show, the four kinds of motions each should appear at least once in set of movements.

Somersault

Athletes complete each kind of gymnastics events turning and soaring movements in the ground, which divides into on spot proceeding and marching process two kinds, it is composed of each kind of roll, walk over, handspring, somersault and turning movement.

Pyramid

Pyramid is one or multiple tops supported by one or multiple base form into pyramid shaped lift mould, the mould members should mutual support, and produce mutual connections, mould should keep vertical state and non-vertical transitional movement is permissible, according to mould formation process, it can be divided into grounding, forming pyramid and undercarriage three steps;

Lift

The kind of movement is the movements modeling process by one or more people composed base lifting top away from ground and completing different postures in different heights, life can be divided according to process as mount, flight posture, dismount, if classifies according to forms, it can be divided into single base lift, double bases lift and multiple bases lift, ac-

cording to lift position, it can be divided into hip, should, high-order and torch;

Toss

Toss kinds of movements is to toss top base from hip to air, so that let it complete different postures' mould, toss and turn in the air, then receive top from base such movement process, the process is divided into throw, flight posture, drop and receive.

If each kind of above four kinds' movement has not appeared in the set of movements, then it will be deducted five scores, it will deduct 10 scores if short of two kinds, the rest can be done in the same manner.

Difficulty movements difficulty levels are classified by athletes adopting movement features, the higher difficulty is the higher corresponding score is, according to difficulty movements' difficulty levels, it can divide each level corresponding scores into 10 levels, difficulty levels and scores corresponding relationships are as TABLE 1 show.

TABLE 1 : LALA gym difficulty levels and their scores corresponding status level score

Level	1	2	3	4	5	6	7	8	9	10
Score	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0

According to LALA gym difficulty movements essential movement features and difficult movements ace influence status on final result, it gets athletes own excellent special quality ability is the premise for them to complete complicated diversity and difficult movements, therefore the chapter summarizes athletes reflected sports ability special quality indicators, as TABLE 2 show.

FACTOR ANALYSIS MODEL PRINCIPLE AND APPLICATION STEPS

Factor analysis model principle

When researching problems, it normally will come across lots of research objects correlated factors, these factors classifies according to type, it can be divided into common factor and unique factor, the former refers to each original variable common factors, it can explain variables correlations, while the later refers to original variables special factors, it cannot be explained by common factor, when making original variables and factor analysis, it needs to extract factor load that using common factors correlations to express, factor analysis general used model expression is as formula(1) show:

$$Z_j = a_{j1}F_1 + a_{j2}F_2 + \cdots + a_{jm}F_m + U_j \left(j = 1,2,\cdots,n\right) \quad (1)$$

In formula (1) Z_j represents the j variable standard fraction F_i represents common factor, m represents the number of all variables common factors, U_j represents variable unique factor represents factor loads.

In formula (1), factors can be understood as higher space mutual vertical m pieces of coordinate axis, a_{ji} is called factor loading, is the j original variable the i factor loading, if regard variable Z_j as dimensional factor space standardized regression coefficient, U is called special factor, represents original variable parts that cannot be explained by factors, its average value is 0, therefore it can regard as further linear regression model residual.

In order to easier describe factor analysis mathematical model, the chapter makes statements by taking three variables extracting two common factors as examples, three variables use Z_1, Z_2, Z_3 to express, two common factors use F_1 and F_2 to express, then three variables linear combinations expressed by two common factors can use formula (2) to express:

In order to easier describe factor analysis mathematical model, the chapter makes statements by taking three variables extracting two common factors as

TABLE 2 : LALA gym athletes' essential special quality indicators

Symbol	Indicator	Content	Symbol	Indicator	Content
Z_1	Index1	number of push up	Z_5	Index5	15s constant grand kick numbers
Z_2	Index2	frontal balance time	Z_6	Index6	hanging leg raise time
Z_3	Index3	standing high area bend forward	Z_7	Index7	15s straddle jump times
Z_4	Index4	rope skipping times per minute	Z_8	Index8	lateral front split

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examples, three variables use to express, two common factors useand to express, then three variables linear combinations expressed by two common factors can use formula(2) to express:

$$\begin{cases} \mathbf{Z_1 = a_{11}F_1 + a_{12}F_2 + U_1} \\ \mathbf{Z_2 = a_{21}F_1 + a_{22}F_2 + U_2} \\ \mathbf{Z_3 = a_{31}F_1 + a_{32}F_2 + U_3} \end{cases} \quad \mathbf{(2)}$$

Transform formula (2) into factor matrix, it can get result as TABLE 3 show.

Commonality refers to every variable total square sum in each common factor loads, that is to say, individual variables' variation amount percentage that can be explained by common factors, the value is individual variables and common factors multiple correlated square, it can judge the original variable and common factor relationship degree from the size of commonality, use 1 minus each variable unique values is commonality value; if commonality is equal to 1, then it represents no unique factor; feature value refers to every

TABLE 3 : Factor analysis linear model converting into factor matrix result table

Variable factor	Common factor one (F_1)	Common factor two (F_2)	Commonality (h^2)	Unique factor (d^2)
Z_1	a_{11}	a_{12}	${a_{11}}^2 + {a_{12}}^2$	$1-{h_1}^2$
Z_2	a_{21}	a_{22}	${a_{21}}^2 + {a_{22}}^2$	$1-{h_2}^2$
Z_3	a_{31}	a_{32}	${a_{31}}^2 + {a_{32}}^2$	$1-{h_3}^2$
Feature value	${a_{11}}^2 + {a_{21}}^2 + {a_{31}}^2$	${a_{11}}^2 + {a_{21}}^2 + {a_{31}}^2$	/	/
Explanation	$\frac{{a_{11}}^2 + {a_{21}}^2 + {a_{31}}^2}{3}$	$\frac{{a_{11}}^2 + {a_{21}}^2 + {a_{31}}^2}{3}$	/	/

variable's factor loading total square sum in some common factors, in factor analysis common factors extracting, bigger feature value common factors will as first factor be extracted, then feature value is the secondary big one, and so on, until feature value be the minimum one, finally lets every common factors feature values divides independent variable numbers, it makes explanation of total variation in factor structure simplifying.

Factor analysis application

The purpose of factor analysis is concentrating original variables, extracting core variables, if it wants to apply factor analysis, firstly it should judge whether observation data is proper for factor analysis or not, then extract common factor, finally calculate each sample factor scores.

STEP1. Apply SPSS software provided four statistics; it can define whether observation data is proper for factor analysis or not that respectively as following show:

Calculate correlation coefficient matrix: If correlation matrix most part of correlation coefficient is less than 0.3, then it is not fit for factor analysis, when there are more original variable numbers, output correlation coefficient matrix is specially big, it will cause inconvenience when observing, therefore generally it will not use such method;

Calculate anti-image correlation matrix: The matrix diagonal line elements are one variable MSA statistics, their mathematical definitions are as formula(3) show:

$$\mathbf{MSA_i} = \frac{\sum_{\mathbf{j=i}} \mathbf{r_{ij}^2}}{\sum_{\mathbf{j\neq i}} \mathbf{r_{ij}^2} + \sum_{\mathbf{j\neq i}} \mathbf{p_{ij}^2}} \quad \mathbf{(3)}$$

In formula(3), r_{ij} represents variable x_i and other variable x_j simple correlation coefficient, p_{ij} represents variable x_j partial correlation coefficient under controlling residual variables, thereupon it can know variable x_i statistics MSA_i is between 0 and 1, the closer

the statistics gets to, then the bigger variable and other variables correlations would be, therefore, when anti-image correlation matrix diagonal line elements get closer to 1, it will more proper to make factor analysis;

Bartlett sphericity test: The test purpose is to test whether correlation matrix is unit matrix or not, if it is unit matrix, then it is thought that it is not fit for applying factor model, when significance level is less than 0.05, then it thought that it is proper for factor analysis, when significance level is above 0.10, then it is thought it is not proper for factor analysis;

KMO measurement: The measurement value represents sampling appropriateness quantities, when the value gets closer to 1.0, then it represents the more variables common factors are, the researched data would be more proper for factor analysis, generally thought that appropriateness is excellent when KMO>0.9, appropriateness is good when 0.9>KMO>0.8, appropriateness is normal when 0.8>KMO>0.78, it is thought that would not proper for factor analysis when KMO is less than 0.7.

Therefore, normally it adopts KMO measurement and Bartlett sphericity test to carry out sample data factor analysis goodness measuring, this paper adopts such two test ways to make goodness test.

STEP2. Extract common factor

Synthesize original variables into fewer some factors, common factor extracting deciding method is principal component analysis, so-called principal component analysis refers to use fewer component explaining original variable variance most parts, when carrying out the analysis method, firstly it should transform every variable value into standard value, then project straight line in space used for explaining maximum variance, the received straight line is common factor, finally it makes factor extracting according to residual variances size.

STEP3. After gaining common factors, which is to analyze each factor, in the hope of getting the purpose of researching, in the step it needs consider selecting factors, samples size, size of factor numbers these three aspects contents, it gets scree plot and its analysis result, finally it produces factor analysis result reports.

FACTOR ANALYSIS APPLICATION IN LALA GYM SPECIAL QUALITY ANALYSIS

LALA gym contrast group and experimental group test indicators comparative analysis

For contrast group and experimental group LALA gym athletes, it makes regrouping with men and women, does Index1-Index8 special indicators test, its test result is as TABLE 4 show.

From TABLE 4 data, it can get as Figure 1 showed two group members eight special qualities data comparison status.

TABLE 4 : Experimental group and contrast group LALA gym sports indicator test comparison result

Indicator classification	Experimental group -Man	Contrast group-Man	Significance-Man	Experimental group-Woman	Contrast group - Woman	Significance - Woman
	$\overline{X} \pm S$	$\overline{X} \pm S$	P	$\overline{X} \pm S$	$\overline{X} \pm S$	P
Index1	52.67±2.57	39.75±4.52	<0.01	22.75±4.86	10.38±2.67	<0.01
Index2	16.75±7.84	34.00±8.64	<0.01	10.00±8.93	20.62±7.56	<0.01
Index3	23.75±2.34	16.00±2.49	<0.01	27.38±1.92	15.88±2.42	<0.01
Index4	116.6±28.4	90.3±23.38	<0.01	101.6±29.0	82.88±19.8	>0.05
Index5	15.92±0.79	12.33±1.37	<0.01	13.88±0.99	9.62±1.19	<0.01
Index6	24.92±1.88	19.75±2.36	<0.01	15.00±1.85	8.38±1.77	<0.01
Index7	13.83±1.12	10.58±1.00	<0.01	8.88±1.64	6.12±0.84	<0.01
Index8	5.50±4.03	27.17±6.58	<0.01	2.38±2.20	17.00±8.07	<0.01

From TABLE 4 data and Figure 1 indicator data statistical comparison Figure, it is clear that women experimental group athletes and contrast group athletes have no significant differences in special quality Index 4 one minute rope skipping quantity, other each special

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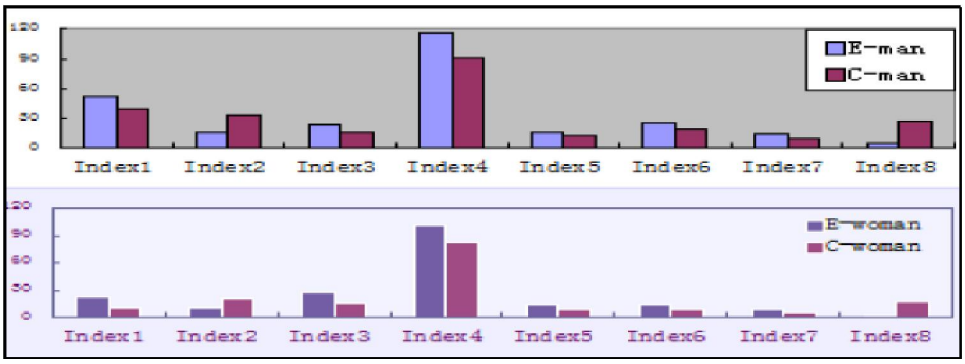

Figure 1 : Experimental group and contrast group members' eight special qualities indicator data statistical figure

indicator, both contrast group men and women and experimental group men and women have significant differences, and experimental group members obviously have an advantage over contrast group.

Factor analysis goodness level test result

According to previous analysis, it is known that Bartlett's test of Sphericity starts from testing the whole correlation matrix, its null hypothesis is correlation matrix that is unit matrix, if the result doesn't refuse null hypothesis, then it needs to consider using factor analysis again, while KMO measurement is used to measure a group of variables' correlation degree, its value is between 0 and 1, according to measurement value affiliates range, it can get factor analysis goodness level, use SPSS software making Bartlett's test of Sphericity and KMO measurement calculation according to TABLE 5 showed correlation coefficient matrix, it can get result as Figure 2 show.

Take TABLE 5 showed correlation coefficient matrix to make KMO sampling goodness test and Bartlett's test of Sphericity in SPSS software, the result as Figure 2 show.

From TABLE 5 data, it is clear that eight special qualities indicators correlations are higher, they have 26 pieces of high correlation that $P < 0.01$,and 12 pieces of certain correlation that $P < 0.05$, from Figure 2 applicability test result, it is clear that Bartlett sphericity test value is 154.542,and

TABLE 5 : Eight special quality indicator correlation coefficient matrix

Indicator		Index1	Index2	Index3	Index4	Index5	Index6	Index7	Index8
Index1		1.00	0.437	-0.662	0.275	0.837	0.947	0.910	0.432
Index2		0.437	1.00	-0.675	0.380	0.482	0.328	0.242	0.937
Index3		-0.662	-0.675	1.00	-0.277	-0.555	-0.541	-0.556	-0.711
Index4		0.275	0.380	-0.277	1.00	0.318	0.166	0.165	0.378
Index5		0.837	0.482	-0.555	0.318	1.00	0.789	0.747	0.432
Index6		0.947	0.328	-0.541	0.166	0.789	1.00	0.944	0.341
Index7		0.910	0.242	-0.556	0.165	0.747	0.944	1.00	0.252
Index8		0.432	0.937	-0.711	0.378	0.432	0.341	0.252	1.00
Sig. (1-tailed)	Index1	0.027	0.001	0.120	0.000	0.000	0.000	0.029	
	Index2	0.027	0.001	0.049	0.016	0.079	0.152	0.000	
	Index3	0.001	0.001	0.118	0.006	0.007	0.005	0.000	
	Index4	0.120	0.049	0.118	0.086	0.242	0.243	0.050	
	Index5	0.000	0.016	0.006	0.086	0.000	0.000	0.029	
	Index6	0.000	0.079	0.007	0.242	0.000	0.000	0.070	
	Index7	0.000	0.152	0.005	0.243	0.000	0.000	0.142	
	Index8	0.029	0.000	0.000	0.050	0.029	0.070	0.142	

Bartlett's Test of Sphericity	Approx. Chi-Square	154.542
	df	28
	Sig.	0.000
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.764

Figure 2 : Factor analysis applicability test result

$P(\text{sig.} = 0.000) < 0.001$, it refuses original hypothesis, KMO sampling goodness measurement value is 0.764 that is between 0.8 and 0.7, it is thought that factor analysis has normal applicability. To sum up, this research sample data and data features meet factor analysis goodness demands.

LALA gym special quality common factors extracting

The purpose of LALA gym special quality common factors extracting is extracting fewer some factors with commonality from experts interviewing results provided eight special quality indicators so as to provide major guidance direction for the event talent selection and scientific training. Through principal component analysis of testing data, it gets feature values, factor contribution ratio and accumulation contributions as TABLE 6 show.

From TABLE 6 data, it can get as Figure 3 showed scree plot.

From principal component analysis, it is clear that features are quite small starts from the fourth component to the eighth component, while the first component to the third component total contribution ratio is 91.083%, therefore this paper selects three common factors, in order to research on three common factors and eight principal components relationships, it applies SPSS software, and gets as TABLE 7 showed three principal factors and eight special indicators factor loading matrix after varimax orthogonal rotation.

From TABLE 7, it is clear that push up, hanging leg raise, 15 seconds straddle split and 15 seconds constant grand kick have high correlations with the first principal factor Component-1, its correlation coefficient

TABLE 6 : Measured data matrix feature value contribution ratio and accumulation contribution ratio result table

Indicator	Feature value	Feature value contribution ratio	Accumulation contribution ratio	Indicator	Feature value	Feature value contribution ratio	Accumulation contribution ratio
Index1	4.824	60.299%	60.299%	Index5	0.221	2.760%	98.156%
Index2	1.661	20.761%	81.060%	Index6	0.064	0.794%	98.950%
Index3	0.902	10.024%	91.083%	Index7	0.058	0.726%	99.676%
Index4	0.345	4.313 %	95.396%	Index8	0.026	0.324%	100.00%

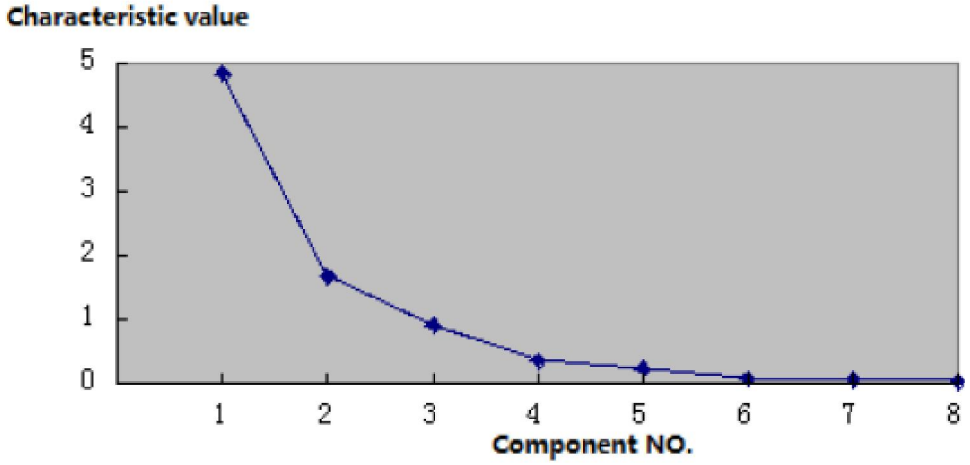

Figure 3 : Principal component analysis component scree plot

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TABLE 7 : Factor loading matrix result after varimax orthogonal rotation

Indicator	Component-1	Component-2	Component-3
Index1	0.930	0.288	0.110
Index2	0.156	0.935	0.184
Index3	-0.485	-0.733	-0.029
Index4	0.113	0.215	0.964
Index5	0.810	0.304	0.210
Index6	0.959	0.172	0.020
Index7	0.964	0.098	0.022
Index8	0.152	0.947	0.167

arrives at more than 0.81, and above four items special quality indicators can reflect athletes' upper and lower limbs exertion speed and strength, therefore Component-1 can be understood as speed strength quality; frontal balance and lateral front split have higher loading with Component-2, its correlation coefficient arrives at more than 0.935, and above two items special qualities reflect athletes' flexibility quality, therefore Component-2 can be understood as flexibility quality; one minute rope skipping has high relational degree with Component-3, its correlation coefficient arrives at 0.964, therefore Component-3 can be understood ad speed endurance quality.

Factor coefficient scoring result

Based on 5.3, it can work out every athlete common factor scores, applies principal component analysis into making linear elimination on eight principal components, it can get as TABLE 8 showed common factor scoring coefficient matrix.

From TABLE 8 showed linear elimination coefficient matrix, it can get as formula (4) showed F_1, F_2, F_3 scoring standardized linear combination expression:

$$\begin{cases} \mathbf{F_1 = 0.269Z_1 - 0.127Z_2 - 0.033Z_3 - 0.046Z_4} \\ \mathbf{+ 0.219Z_5 + 0.305Z_6 + 0.320Z_7 - 0.130Z_8} \\ \mathbf{F_2 = -0.040Z_1 + 0.447Z_2 - 0.314Z_3 - 0.157Z_4} \\ \mathbf{- 0.036Z_5 - 0.087Z_6 - 0.130Z_7 + 0.459Z_8} \\ \mathbf{F_3 = 0.004Z_1 - 0.046Z_2 + 0.186Z_3 + 0.039Z_4} \\ \mathbf{+ 0.121Z_5 - 0.069Z_6 - 0.047Z_7 - 0.069Z_8} \end{cases} \quad \mathbf{(4)}$$

To sum up, in actual movement, LALA gym the special sports event, it needs athletes to show dynamics feeling, that is to say, it need athletes' limbs movements completed by short accelerating and position braking, while long time complicated and diversity arms combination process and high difficulty cooperation techniques as well as before and after tossing jumping movements, all need to realize by limbs muscles rapidly force exerting, therefore speed strength quality is excellent LALA gym athletes' essential preferred quality, entire exercise completion needs the action in place and soft, flexible, which requires body each segment has good flexibility, therefore LALA gym athletes' essential second-rate quality is flexibility quality, and due to the event movement time is proceeding within 2.5 minutes, it relatively sports intensity and sports time are longer, it needs athletes have good endurance qualities, so the paper extracted three major components conform to practice.

TABLE 8 : Principal component analysis linear elimination factor scoring coefficient matrix output result

Indicator	Symbol	Component-1	Component-2	Component-3
		F_1	F_2	F_3
Index1	Z_1	0.269	-0.040	0.004
Index2	Z_2	-0.127	0.447	-0.046
Index3	Z_3	-0.033	-0.314	0.186
Index4	Z_4	-0.046	-0.157	0.039
Index5	Z_5	0.219	-0.036	0.121
Index6	Z_6	0.305	-0.087	-0.069
Index7	Z_7	0.320	-0.130	-0.047
Index8	Z_8	-0.130	0.459	-0.069

CONCLUSIONS

In the paper, it made questionnaire survey on LALA

gym sports special qualities, and extracted eight special sports qualities after expert interview selection, applied factor analysis making sports test results comparative analysis of these special sports qualities, analyzed experimental group that was composed of excellent 20 LALA gym athletes and contrast group that was composed of normal 20 LALA gym athletes significance differences, and utilized factor analysis principal component analysis getting three common factors, and used linear combination way getting three principal component factors expressions, which proved LALA gym athletes' essential speed strength quality, flexibility quality and endurance quality rationality, so that provided theoretical basis for LALA gym exercise teaching and analyzing.

ACKNOWLEDGMENT

The specialized research fund for 2010 project of Xianyang Normal University (Number: 10XSYK328).

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