CORRELATION ANALYSIS OF THE INTEGRAL THE FITNESS OF GYMNASTS 12-17 YEARS OLD

Professor [1]**Umarov Mars Narzievich,**
Professor [2]**Tajibaev SoyibSamijonovich,**
Honored Master of Sports of the Republic of Uzbekistan
[3]**Sanokulova ZamirajonBakhtiyorjonovna**

ANNOTATION
The materials of the correlation analysis allowed us to study the peculiarities of the connection of various aspects of the integral fitness of gymnasts with their sports and technical skills. The matrix of the 20th order was analyzed by the method of the main components, which includes the main indicators characterizing the training process of young gymnasts aged 12-17 years.
KeywordsModel, correlation analysis, factor analysis, physical development, testing, physical fitness, technical training, and control tests, sports and technical skills.

INTRODUCTION
In recent years, modeling of the main aspects of mastery and training methods has become widespread in the athletes' training management system. L.Ya.Arkaev (1), Yu.K.Gaverdovsky (2,3), V.N.Platonov (4), V.S.Cheburaev (6) believe that at the present stage of the development of high-performance sports, it is time to create step-by-step intermediate models of athletes of various qualifications and training impact programs necessary to achieve a certain level of sports and technical skill (5,7) to optimize the training process.

The model is a set of basic parameters that determine the achievement of a certain level of sportsmanship and predicted results (1,3,4,7). Individual indicators included in the model are considered as model characteristics (2,4,5,7). Qualitative and quantitative indicators necessary for modeling are obtained by examination, testing, various experiments, expert assessments of specialists, etc. (1,5,7). Depending on the purpose of management, the following types of models are distinguished: basic, perspective, theoretical and mathematical. The basic models are the requirements that the athletes' readiness for a certain period must meet. A promising model is a forecast of the possible results of prize winners or winners. A theoretical model is a system of knowledge that describes and explains the totality of phenomena of some aspects of athletes' fitness from a single point of view. A mathematical model is equations, graphs, etc. They are based mainly on the results of correlation, factorial, regression and variance analyses.

In the course of research, a mathematical model of correlation and factor analysis of the fitness of promising young gymnasts will be considered.

Research objectives

1. To determine the factor structure of the preparedness of young gymnasts of various ages and qualifications.

2. To identify the influence of various aspects of preparedness on the success of competitive activity of gymnasts.

Organization of research

The research was carried out under the conditions of a centralized form of training for promising gymnasts - 1th category, candidates for masters of sports and masters of sports (MS) aged 13-18 years, who respectively passed the prospective and pre-Olympic selection and are at the stage of in-depth sports training and sports improvement. The gymnasts were divided into three groups by age: 13-14, 15-16 and 17-18 years. The complex of tests included exercises and tests recommended by Yu.K.Gaverdovsky et al. (2), characterizing physical, technical training, physical development and work capacity (loads).

At the first stage, motor tests were checked for in formativeness, objectivity and reliability. The check showed their authenticity (goodness). All tests on especially physical (SP) and technical (TP) training have good and excellent assessments of objectivity and reliability. Correlation coefficients in the range of 0.910 - 0.990.

The validity of individual indicators and tests by types of fitness of gymnasts in different age periods varies significantly. At the same time, their correlation with the sports and technical result in the types of gymnastic all-around, the specifics of which they reflect, is higher than in the all-around. Integral indicators of relative strength, physical and technical fitness and training loads are the most informative, which, in general, speak in favor of an integrated approach in assessing any fitness of gymnasts (Table 1):

Table 1

Integralindicators	Sportsandtechnicalresult		
	13-14 year	15-16 year	17-18 year
Relativestrength	0,630	0,719	0,684
Physicalfitness	0,946	0,518	0,873
Technicalpreparedness	0,783	0,867	0,807
Trainingloads	0,661	0,715	0,767

The empirical (calculated) in formativeness of the tests used by us to assess physical and technical fitness is supplemented by meaningful (logical) in formativeness, since they are exercises included in the competitive programs of gymnasts, i.e. part of those motor actions that an athlete performs during competitions.

Correlation analysis. A correlation analysis was carried out to study the relationship of various aspects of gymnasts' fitness (physical development, physical and technical fitness and training loads) with their sports and technical skills. The athletic and technical skill of promising gymnasts was assessed by two indicators, or two components. The first part is the sports result (scores at competitions); the second part was technical readiness, which was assessed by the number of learned elements of the highest difficulty group, support jumps and by the number of similar exercises included in arbitrary programs at competitions, i.e. implemented in competitive combinations. The material for the correlation analysis was data on 67 parameters obtained in the course of preliminary studies on promising gymnasts.

Physical development, sports and technical skills. Correlation analysis showed that gymnasts aged 12-17 years had a reliable relationship between physical development data and ath-

letic results only for certain types of gymnastic all-around: at 12-13 years, body length with a result on the uneven bars (0.344), at 14-15 years, the result on a horse with a body length (0.367), with a Broke index (-0.390), at 16-17 years, the result on a horse with a body weight (0.392). In connection with physical development and sports and technical result, there are periods of decrease and increase in the correlation coefficient due to age-related changes and the impact of gymnastics. The relationship of physical development with the technical fitness of gymnasts is most significant at 13-14 years old, both in terms of the number of correlation coefficients and in terms of significance (0.433- 0.587). With age, the closeness of the connection decreases.

MATERIALS AND METHODS

Technical readiness is a sporting result. The analysis of the research materials showed that the number of learned elements of the highest difficulty group (a group of super-complex elements were not taken into account in the analysis, since their small number in each other anthem is literally one) reliably correlates with almost all results on shells in all age groups (0.576-0.897), except for estimates on the support jump (0.127), and there is a noticeable tendency to increase the correlation coefficient with the age and qualifications of gymnasts: at 12-13 years - on the crossbar and horse, at 14-15 and in 16-17 years old - on the crossbar and rings.

The number of elements of the highest group of difficulty included in the combination significantly correlates mainly with the scores on floor exercises, horse and rings in all age groups, and the number of support jumps learned and included in competitive programs is only with the score on jumps. All four types of technical readiness indicators have a reliable relationship with the sum of points in the all-around. A higher relationship was revealed between the integral indicator of technical readiness both with the result in the all-around and on individual shells, moreover, with the age of gymnasts, this relationship becomes closer.

Thus, it has been established that there is a rather significant dependence of the sports and technical result on the level of technical readiness, i.e. on the number of complex elements of the highest difficulty group learned and included in competitive combinations. This dependence can be regarded as follows: the greater the margin of difficulty of gymnasts, the better they perform at competitions, and the more complex their competitive programs, the higher the competitive results. However, the difficulty of young gymnasts often comes at the expense of the quality of performance, especially at the stage of the formation of sportsmanship, since young gymnasts must constantly increase the number of elements in combinations and increase their complexity. The instability of competitive combinations, both in complexity and in the number of elements, can be explained by a not very high level of correlation coefficients.

The integral result is a unified indicator and when determining the level of technical readiness of gymnasts, it is necessary to focus on it.

Physical fitness - sports and technical skills. Analysis of the relationship between the results of control exercises (tests) for special physical fitness and sports and technical results in both individual types of gymnastic all-around and all-around, revealed that those tests that reflect the specifics of working on the projectile have higher correlation coefficients with this type of all-around. Speed and strength tests (running 20 meters, rope climbing and long jump from a place) have higher connections with free exercises, support jump and rings. Tests for dynamic and static strength are interconnected with rings, bars and a horse; flexibility (the sum

of allowances for errors in performing seven exercises) - with free exercises and a horse; special endurance (the number of laps on a horse) - with the result on a horse.

The relationship of individual tests with the sum of scores in the all-around is somewhat lower, but in most cases this relationship is reliable, or it tends to be reliable. The highest correlation coefficients between the integral indicator of special physical fitness and the sum of all-around scores in 12-13 years - 0.946; in 14-15 years - 0.918 and in 16-17 years - 0.873.

More than half of the tests used have a reliable relationship with both the number of learned and included in the combination of elements of the highest difficulty group. The integral indicator of special physical fitness is associated with higher correlation coefficients both about the number of elements learned and included in the combination of the elements of the highest difficulty group.

Thus, the validity of individual tests changes with age, both with the result in the types of gymnastic all-around and with the volume of learned and included in the combination of elements of the highest group of difficulty. It turned out to be quite difficult to choose which test is more valid, at what age. Both in terms of the number of reliable connections and their level, all age groups are approximately the same, but there is still a tendency to increase the importance of these connections with increasing age, especially in tests related to the strength training of gymnasts.

It should also be noted that not all the tests we used were end-to-end, so it is somewhat difficult to compare gymnasts by age.

So, the technical skill of gymnasts largely depends on the general level of special physical training.

Relative muscle strength - athletic and technical skill. The close connection of the sports and technical result with the indicators of relative strength is revealed. With age and advanced training, the number of reliable correlation coefficients increases. The most significant correlation coefficients were found between the sports result and the relative strength of the muscles (0.727) carrying gymnastics-specific loads (shoulder extensors, adductors, hip extensors and foot flexors). The significance level of these correlation coefficients also increases with age. This increase is probably due to the fact that strength training has an increasing impact on the level of technical skill of gymnasts.

The strongest connection with the technical skill of gymnasts was also revealed by the integral indicators of relative and absolute muscle strength.

Training loads - sports and technical skills. The total amount of training loads reliably correlates with the results on all the gymnastic all-around equipment (0.575-0.889), with the exception of the result on the support jump, here the relationship has not reached a reliable level in all age groups. In turn, the sum of points in the all-around in all age groups also has a reliable relationship with the amount of work performed on individual shells. The exception is also the support jump. It is characteristic that with increasing age and qualifications, the level of correlation coefficients between the amount of training load and the sports result also increases, especially on power-type projectiles.

Higher correlation coefficients between the load performed on a particular type of gymnastic all-around and the score on this type. A cross- (indirect) correlation was also revealed, when the load performed on one projectile affects the result on another projectile.

Thus, the volume of the load performed on the bars affects the result on the horse and rings; on floor exercises - on the support pole; on the crossbar - on the rings.

The volume of the performed load on special physical training (SPT) reliably correlates with almost all the results in the types of all-around, excluding the crossbar and jump. The most significant relationship was revealed between the training load and the sum of points in the all-around (0.797).

The technical readiness of gymnasts aged 14-17 (in terms of the number of elements of the highest difficulty group learned and included in combinations) mainly depends on the volume of training loads on such projectiles as rings (at 12-13 years old); rings, bars and crossbar (at 14-17 years old). The number of support jumps learned and included in competitive programs depends only on the amount of load on this type.

The method of principal components with rotation of reference axes according to the Varimax criterion was used. Initially, 17-19 factors were identified in each group, then, according to the results of the correlation analysis, derivative and duplicate indicators were excluded. Of the 67 indicators, only 20 were left in each age group. By the method of principal components, a matrix of the 20th order has now been analyzed, including, in our opinion, the main of the above indicators. The analysis showed that the morph-motor structure of promising gymnasts can be represented by four orthogonal factors; i.e. an intercorrelation matrix with leading factors was obtained.

These factors account for between 74-78% of the total discussion sample. Each age group and sports qualification is characterized by a specific morpho-motor structure with the presence of a certain correlation between factors with physical qualities and motor abilities and sports and technical readiness of promising gymnasts. Significant indicators have been established that must be taken into account in sports orientation and which can be used in the development of model characteristics (Table 2).

RESULTS AND DISCUSSIONS

The contribution of the first factor (technical skill or preparedness) to the generalized dispersion sample of gymnasts aged 13-14 years is 26.9%. This included high factor weights of technical fitness indicators of gymnasts (the number of learned and included in the combination of elements of the highest group of difficulties and sports results both in the types of all-around and in the all-around), in addition, a significant relationship with strength training was revealed.

Table 2

Factor structure of fitness of gymnasts aged 13-18

№ factors	F a c t o r s	The contribution of the factor to thevariance	Overall contribution
12-13year(1-th)			
I	Technicalpreparedness	26,9	
II	Physicaldevelopment	16,5	
III	Trainingload	16,4	75,0
IV	SFP (+ endurance, proportions)	15,0	
14-15year			

I	Relativestrength	32,9	74.1
II	Technicalpreparedness	20,4	
II	Physicaldevelopment	11.3	
IV	SFP (+ loads, proportions)	9,5	
16-17year			
I	Trainingload	28,4	77,7
II	Technicalpreparedness	20,2	
III	Relativestrength	14.9	
IV	SFP (+ flexibility, proportions)	14,4	

The first factor in gymnasts aged 14-15 is named by us as a factor of relative strength. Its contribution to the variance was 32.9%. High factor weights here have indicators of the relative strength of the main muscle groups, significant speed and strength qualities (running 20 meters, etc.) and loads for special physical training.

The share of the first factor in athletes aged 16-17 accounts for 28.4%. This is a load or performance factor. In addition, this factor with high correlations included indicators of physical development and absolute strength.

The share of the second factor among gymnasts of the first category falls 16.5%. This is a factor of physical development of gymnasts; its basis is weight and height indicators.

Among the candidates for the master of sports, the second factor is called by us the factor of technical preparedness and skill. Its weight is 20.4%. As mentioned above, by technical skill we mean the volume of technically complex motor skills by types of all-around and the number of support jumps, as well as the sports results shown by gymnasts in the all-around and in its individual types.

The contribution of the second factor to the generalized variance among masters of sports was 20.2%. The highest factor weights are also indicators of technical skill of gymnasts, this factor is similar to the second factor identified in the training of gymnasts aged 14-15 years. (Candidates for master of sports).

The third factor with a weight of 16.4 in the total sample of gymnasts of the 1-th category aged 12-13 is more associated with training loads in the all-around and the total load of gymnasts. In addition, it includes indicators indirectly characterizing sports performance, such as vital capacity of the lungs, chest circumference, etc.

At the age of 14-15, the third factor was interpreted by us as physical development. His contribution was 11.3%. These are the weight and height indicators and body proportions of gymnasts of this age. A significant connection here is revealed with physical fitness, namely with test indicators of strength, flexibility and speed-strength qualities.

The contribution of the third factor to the generalized sample of masters of sports is 14.9%. We called it the relative strength factor of gymnasts. This includes statistically significant correlations (correlation coefficients) with the relative strength of all major muscle groups and the integral index.

The significance of the fourth factor among gymnasts of the I-th category was 15.0%. This is a generalized factor of special physical training with a tendency to endurance and

strength of the arms and shoulder girdle. A significant connection was revealed with the proportions of the gymnasts' bodies.

The share of the fourth factor in 14-15-year-old gymnasts, candidates for master of sports, accounts for 9.5%. We have also generalized it as a factor of special physical training, although it is quite differently planned. However, it is dominated by endurance, torso strength and training loads according to SFP. Indicators of athletes' body proportions reach a significant level.

The contribution of the fourth factor in highly qualified gymnasts aged 16-17 to the generalized dispersion sample was 14.4%. This factor can be called a factor of special physical training, but with the predominance of the weight of flexibility. There is also a significant relationship with the proportions of the body.

As we can see, the fourth factor in all three age groups of athletes of different qualifications is common. This is a factor of special physical fitness and body proportions. The latter, as is known, affect the indicators of the physical qualities of gymnasts. The length of the arms and torso are interconnected with the strength of the gymnast.

Similarly, the factor structure of physical fitness of young gymnasts was revealed, the main content of which was tests aimed at strength training. The factor structure of the physical fitness of gymnasts aged 12-I7 is shown in Table 3.

In the table, instead of factor weights, the movement of factor numbers (places) is shown or a change in the significance of each factor with an increase in the age and qualifications of gymnasts.

Thus, the factor structure of the fitness of gymnasts aged 12-17 years (I category,

CMS, MS) is determined by a set of the following main factors:

~ factor of physical development;
- Relative strength factor;
- The factor of technical preparedness
- The factor of physical fitness;
~ Load factor (working capacity).

Table 3

The most informative are the integral indicators for the types of fitness of gymnasts.

Physicalqualities	Factornumbers		
	12-13 yearsold 1 category	14-15 years	16-17years
AbsolutePower	5	3	2
Relativestrength	5	4	3
Staticforce	4	I	I
Dynamicforce	T	I	3
High-speedpower	3	3	4
Flexibility, mobilityinjoints	4	2	4.
Endurance (special)	3	2	I

For each age group and various qualifications of stove gymnasts, their own "model" of the morph-motor (factor) structure of physical (strength) and general fitness and the correlation of correlations were revealed.

The use of this factor analysis will allow you to purposefully build a training process in gymnastics.

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