Algorithm of athletes' fitness structure individual features' determination with the help of multidimensional analysis (on example of basketball)

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Abstract

Purpose: to determine main laws of determination of athletes' fitness structure's individual characteristics with the help of multidimensional analysis (on example of basketball).

Material: in the research elite basketball players (n=54) participated. Pedagogic testing included 12 tests, applied in combined teams of Ukraine and Russia. For every test three attempts were given and the best result was registered. The tests were passed during 2-3 training sessions.

Results: we worked out general scheme of ways of athletes' training individualization. For every athlete we determined the groups of leading and secondary factors in individual structure of fitness. The process of athletes' training shall contain basic and variable components. Basic component was 70% of means in general system of athletes' training. Variable component was 30% of means and implies application of individual training means. Percentage of means in individual programs varies depending on the following: leading factors in fitness individual structure; period of individual dynamic of competition efficiency. In every micro-cycle 30% is assigned for athletes' individual training: athletes received individual tasks; groups on the base of cluster analysis data were formed, if necessary.

Conclusions: when working out individual training programs, development of leading factors in individual factorial structure of athletes' fitness shall be accented. Application of individual programs, combined with universal individualization methods creates preconditions for rising competition activities' efficiency.

Keywords: structure, sports, individual approach, algorithm, basketball, factorial, cluster, analysis.

Introduction

At present individual approach is one of the main problems of elite athletes' training. Even with successful sport selection the problem of individual approach to training of every athlete is still relevant. With it integrated approach to usage of physiological, biomechanical and psychological indicators is required. This problem concerns individual and team kinds of sports. In team kinds of sports players of different game roles differ by morphological, physiological and biomechanical parameters. Besides, individual differences are characteristic also for players of one game role. Disadvantage of individual approach can result in negative after effects in athletes' training: reduction of competition efficiency; loss of training process's effectiveness; traumatism and psychological problems.

Just the problems of athletes' traumatism are studied in many works. Mainly, means of traumas' prophylaxis and treatment of knee and ankle joints are analyzed. Especially this problem is characteristic for sportsmen of contact kinds of sports (basketball, handball, football and so on).

J. M. P. Andreu [1] analyzed aspects and frequency of traumatism in individual and team kinds of sports. The author found interconnection between sport/personality's factors and frequency/heaviness of traumas in individual (swimming, tennis and light athletic) and team (basketball, handball, football) kinds of sports. He found that frequency and heaviness of traumas are confidently higher in young athletes and sportsmen of team kinds of sports. Thus, this research shows demand in consideration of athletes' individual psychological features for prevention of traumatism.

L. J. Backman and P. Danielson [5] showed that characteristic for basketball players increased traumatic hazard of ankle joint results in restriction of its mobility and reduction of bending angle. Such change results in emersion of patella pathologies. Thus, disordering of one joints' functioning results in disordering of functioning of other joints. That is why it is so important to prevent athletes from traumatism. For this purpose it is necessary to consider individual biomechanical characteristics of every athlete's movements.

D. R. Clifton et al. [10] found higher frequency and heaviness of ankle joint's stretching among sportsmen of American football, comparing with athletes'- beginners. However, prophylaxis of such traumas it is necessary to start just at the beginning of trainings. It will permit to avoid such traumas in the future and implies individual approach to training process's planning.

It would be logical to assume that consideration of

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athletes' individual features creates conditions for better ergonomics and effectiveness of training process. It is one of conditions of traumatism's prevention.

Deficit of athletes' individual features' consideration can also lead to risk of different diseases. Casals et al. [9] showed that there is high risk of pulmonary embolism in basketball players. The authors found that in average frequency of such disease are 1.27 and 2.06 cases per 1000 players in year. This frequency is much higher than in general population researches for analogous age group. The authors also found that basketball players have higher risk of pulmonary embolism, comparing with their peers from general population. The authors concluded that additional researches are required for confirmation of these conclusions. For this purpose it is necessary to find factors, predisposing such disease. It will help to work out the methods of pulmonary embolism prophylaxis in basketball players. Such problem can also reflect the demand in individual approach to trainings' planning in different kinds of sports.

These conclusions are in agreement with works of D. T. Brunelli et al. [7]. The authors found that training and competition periods can result in increase of upper respiratory tract diseases in athletes-adolescents. It can be connected with emersion of inflammatory processes, connected with immune weakening as a response to overloading at trainings and competitions. Consideration of athletes' individual features with the help of complex analysis of their fitness can help to avoid such after effects.

For working out prophylaxis measures against traumatism and diseases of athletes it is necessary to fulfill comprehensive analysis of athletes' individual features. Such analysis shall include morphological, physiological, psychological and biomechanical parameters. The methods of multidimensional analysis (factorial, and cluster analysis) of athletes' complex testing are the most suitable for this purpose.

Such methods of mathematical-statistic data processing are the most frequently used in psychological researches at present time. Sports are not exclusion. One of popular directions of modern researches is determination of psychological and psycho-physiological characteristics of different kinds of sports representatives and athletes of different game roles in game kinds of sports. This direction also reflects study of individual approach in athletes' training.

With the help of different factorial analysis methods of psychometric scaling results J. L. Arias-Estero et al. [2] found high correlation of different perception's components (meaning perception of basketball players' own sportsmanship) and received enjoyment from practicing this kind of sports. The received data witness about high informative value of multidimensional analysis methods.

With the help of different psychological researches in aggressive kinds of sports S. Avugos and M. Bar-Eli [4] showed arguable character of commonly accepted psychological affirmation that success results in the next success and failure results in the next failure. The authors point at the fat that this affirmation is far from being correct for all situations in sports. Such affirmation is correct for people with certain individual features.

P. K. Belling and P. Ward [6] showed the importance of baseball players' cognitive training with the help of specially worked out video scenarios. Application of such technologies resulted in increase of competition activity's effectiveness. The received data are in agreement with results of other studies [36]. Conscious fulfillment of different technical and tactic elements leads to formation of the most effective individual techniques for every athlete. In other works effectiveness was shown: application of methods of mind's activation with the help of information technologies of football's technique and tactic visualization [23]; effectiveness of methods of tactic actions' visualization in female basketball players with hearing problems [22, 34]; effectiveness of methods for increasing consciousness in regulation of female basketball players' physical load [25].

In athletes' training great importance is assigned to the following: optimization of physical load [18, 19] and conscious fulfillment of physical exercises [27, 29, 35]; consideration of didactic laws of training process's construction [3]; choosing of adequate tests for athletes' fitness [16, 20]; consideration of models of coach's (pedagogue's) interconnection with athletes [15, 28]; substantiation of individual training models' construction [12, 13] and criteria of successfulness in competition activity [14, 31]; influence of physical qualities on athletes' workability [30, 33].

Other authors offered conception of training process's individualization, which implies application of multidimensional methods [24]. In detail, this conception implies: determination of group and individual factorial structure of complex fitness with the help of factorial analysis; determination of mathematical regularities of competition efficiency's individual dynamic; application of information technologies. They showed effectiveness of multidimensional analysis methods for determination of athletes' individual features. The authors also specified mathematical regularities of strength, quickness and endurance dependence on athletes' anthropometric data [26]. Also mathematical model of integral training of strength, quickness and endurance for representatives of kinds of sports with complex manifestation of physical qualities was worked out [21]. The authors presented the model of gradual change of different loads by principle of logarithmic spiral.

This conception is based on systemic analysis and specificities of self-organizing systems' functioning [32]. Functioning of any self-organizing systems implies the presence of target, the structure with hierarchic organization and certain regularities of development of development. The same principles are presented in conception of athletes' trainings' individualization, reflected in quantitative characteristics, received with the help of multidimensional analysis methods [24].

The presented literature data condition the demand in further researches, devoted to application of

multidimensional analysis methods for determination of athletes' individual features. Especially urgent is development of algorithm for athletes' determination of group and individual factorial structure of athletes' fitness. Working out of algorithm for finding the groups, inside which athletes are the most similar is also relevant.

The purpose of the research is to determine main laws of determination of athletes' fitness structure's individual characteristics with the help of multidimensional analysis (on example of basketball).

Material and methods

Participants: in the research elite basketball players n=54), average age 21.3 years, average height 180±4.16 cm average weight – 73±7.8 kg, participated. The athletes' qualification: 1st sport category (n=28), candidates master of sports (n=19), masters of sports (n=9).

Organization of the research:

Pedagogic testing included 12 tests, applied in combined teams of Ukraine and Russia [26]. Fulfillment of every test implied 3 attempts with registration of the best results. The testes were conducted during 2-3 trainings. Time was registered by electronic stop-watch.

Description of the tests:

20 m run with registration of time of passing 6 meters' fragment (sec.).

28 m run (the length of site) with stoppage and hand touching of face line and return back. Time of fulfillment was registered.

High jump from the spot. The athlete's height with raised arm was measured. After it, high jump with pushing by two legs was fulfilled. The highest point of hand touching the stand was measured. The difference between the data was calculated in cm.

High jump from run (pushing by one leg – analogous two step throw in the ring). The testing was conducted by the same methodic as at high jump from the spot (cm).

Jumping for quickness. By corners of square stands are located. By square diagonals ropes are tightened (skipping ropes) at 30 cm height. During 20 seconds circular jumps were fulfilled over the ropes. The quantity of jumps was registered.

Technique for quickness. Dribbling of ball with following throw in basket was fulfilled. Condition was compulsory hitting the ring. Then, athlete fulfills dribbling in reverse direction between stands. The time of the test's fulfillment was registered. With missing the ring results was not considered.

Throwing of 3 kg filled ball by one arm from run (the distance of run not more than 5 m). The distance of ball throw was registered (m).

Throwing of 3 kg filled ball by one arm from the spot. The distance of ball throw was registered (m).

Speed of defensive movements (see fig.1). The test requires compulsory touching of the marked points. The time of this test's fulfillment was registered (sec.).

Throws from average and far distance (see fig. 2). The throws were fulfilled from 10 points, located at 4-6.5 meters' distance from the ring. In total 40 throws were fulfilled. In total 40 throws were fulfilled. The quantity of hits was registered and percentage of hits – calculated.

Penalty throws. 20 penalty throws, by 2 throws' series in ring were fulfilled. Athlete independently chose ball after second throw and moved (with dribbling) to opposite side.

Endurance for quickness. Shuttle run 5xL with high jumping and touching the board, where L – the length of site. 3 attempts with 30 se. rest between the attempts. The sum of 3 attempts' fulfillment was calculated (sec.).

The methods of athletes' organism's functional state determination: Blood pressure was registered with the help of membrane device of general purpose (athlete sits

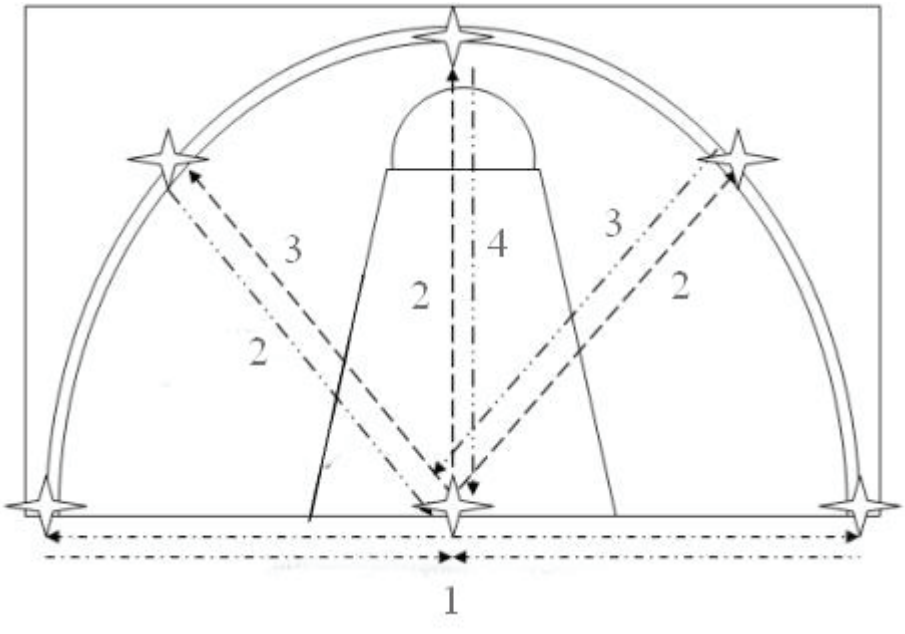

Fig.1. Diagram of test "Speed of defensive movements": 1 – Moving by side steps; 2 – Run with face forward; 3 – Defensive movements with back forward; 4 – Usual movements with back forward.

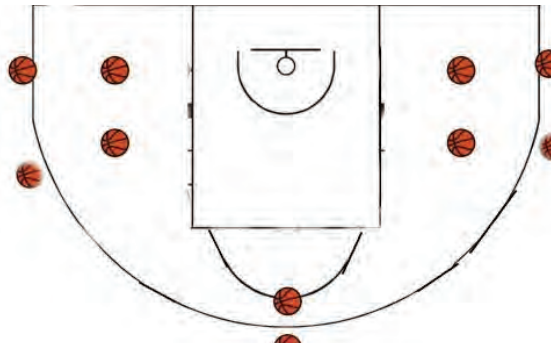

Fig. 2. Diagram of throws' fulfillment from average and long distance.

on chair). The measurements were fulfilled 2 times with interval minimum 5 minutes. Average result in mm/merc. col. was registered.

Indicators of variation pulse metering: for analysis of vegetative regulation of cardio vascular functioning we used one of mathematical statistic methods of heart beats rate variability – variation pulse metering. Recording of signal was realized on portable cardio graphic device. The recording was fulfilled during 5 minutes in lying position after 5 minutes' rest.

The following cardio-intervals' processing permitted to determine a number of cardio rhythm variability's statistical characteristics [24]:

As indicators of heart beats rate we found:

Mo (mode of RR-intervals' duration) the most frequent interval between teeth RR (sec.);

AMo (amplitude of mode of duration of RR-intervals) – percentage of intervals' quantity (the most frequent) to the total quantity of the measured intervals (in our case we used 50 RR-intervals) (%);

Δx – variation range of RR-intervals' duration: there is difference between the highest and the least value of RR-intervals (sec.);

Index of tension (conv. un) of regulatory mechanisms (IT) we found by formula:

$$IT = AMo / 2Mo \bullet \Delta x \qquad (1),$$

Where Δx - is the value of variation range of RR-intervals' duration (sec.);

Mo – mode of RR- intervals' duration (sec.);

AMo - amplitude of mode of duration of RR-intervals (%).

The enlisted indicators of heart beats rate reflect different contribution of sympathetic and para-sympathetic sectors of vegetative nervous system in regulation of heart functioning. Increase of AMo duration of RR-intervals and IT witness about tonus increase of sympathetic sector. Increase of variation range of RR- intervals' duration witnesses about increase of para-sympathetic sector's influence [9].

Method of workability determination by sub-maximal test PWC$_{170}$. This test was approved by World health protection organization (WHPO) for determination physical workability by reaching heart beats rate (HBR) 170 bpm $^{-1}$ (power of physical load is expressed in kgm/min or W). Such load level is the indicator of PWC_{170}. The test is fulfilled in the following way: on ergo meter athlete fulfills two loads of different power (N1 and N2, duration – 5 minutes each, with 3 minutes rest between them). The load is chosen so that to receive several values of pulse in the range from 120 to 170 bpm^{-1}. At the end of each load HBR is determined (accordingly f1 and f2). After it load (at HBR 170 bpm^{-1}) is calculated by graph or by formula:

$$PWC_{170}=N1+(N2 - N1) \times (170-f1) / (f2 - f1) \qquad (2),$$

Where N1 and N2 – two loads of different power in test PWC_{170},

f1 and f2 – HBR after first and second load.

For comparing of the similar relative indicators of workability are usually calculated: PWC_{170} is divided by athlete's weight. In our research we used absolute values and relative PWC_{170} indicators. The testing was conducted on ergo meter Kettler AX1.

Determination of organism's adaptive potentials

For determination of organism's adaptive system's effectiveness we used biochemical blood tests. The tests were conducted with the help of practicing endocrinologist on the base of Institute of medical radiology, named after S.P. Grigoryev of AMS of Ukraine. As analyzes indicators we chosen: cortisol, insulin, optiony peptide of β-endorphin (regulates organism's adaptive systems' functioning) and hemoglobin concentrations. Besides, we calculated tension index of adaptation systems by formula

$$ITk/i = [(k2 \times 100\%) \div k1]/[(i2 \times 100\% \div i1)] \qquad (3)$$

Where IT – tension index of adaptation systems;

$_{k1}$ – mean cortisol concentration in group before experiment;

k_2 - mean cortisol concentration in group after experiment;

i_1 – mean insulin concentration in group before experiment;

i_2 - mean insulin concentration in group after experiment;

As it is known, index c/I (in our case – index of adaptation systems' tension) – is relation of normal values' percentage of cortisol and insulin. The lower it

is the higher are organism's compensatory reserves. The testing was conducted at 8 ^{30} a.m. fasting.

The methods of psycho-physiological indicators' registration.

Registration of psycho-physiological indicators was fulfilled with computerized methods of research. As psycho-physiological indicators we registered speed of simple reaction to sound, to light and tapping test.

The method of determination of kinesthetic sensitivity's threshold

Kinesthetic sensitivity is one of the main indicators of nervous muscular apparatus's functioning. Preciseness is the main indicator of game effectiveness in basketball.

Measuring of kinesthetic analyzer's sensitivity was fulfilled with the help of kinesthesiometer (Kinaesthesiometer) — instrument for determination of human awareness of own muscles and joints' movements. In the process of measurements athlete holds light polyethylene bag filled with water, coming from glass vessel, in the right hand. Water volume was measured with graduated glass tubes, which are connected with vessel and bag by rubber tubes. The weight of bag together with ball and rubber tube is 70 g. Water comes to the bag until the tested starts to feel initial weight increment.

Minimal weight increment is registered by experimenter as threshold of distinguishing (g). After ir initial weight is set again. In the course of experiment 16 thresholds of distinguishing are registered after every minute interval. From all values average threshold is calculated. It is used as indicators of relatively constant sensitivity level of kinesthetic sensor system.

With initial weight of 70 g sensor metering permits to find the state of the most sensitive sensor channels of kinesthetic analyzer.

Statistical analysis: it included application of factorial analysis by main components' method and further determination of factorial values for every athlete. Besides, we used hierarchic cluster analysis. Mathematical statistic processing was fulfilled with the help of «EXCEL», «SPSS» computer programs.

Results

Basing on literature data generalization, results of our experiments and fulfillment of general theoretical-analytical work we worked out general scheme of ways of athletes' trainings' individualization [24, 26, 36].

The first direction of these series of researches implies creation of algorithm of mathematical systemizing and processing of wide spectrum of indicators, reflecting separate sides of fitness and player's state (as system). Such direction regards the state of player or group of players in definite period of time.

The second direction is connected with analysis of factors, conditioning individual dynamic of athletes' game efficiency.

The third direction of the research is connected with development of universal methods, permitting to individualize different aspects of training process.

On the base of the received results individual programs for athletes' training are created.

Such principles can be applied for athletes of different qualification, age, kind of sports and other individual or group peculiarities.

Let us regard main stages of algorithm of the first direction of this scheme. In its base there is processing of testing indicators' wide range with the help of factorial analysis by method of main components (see fig. 3).

Algorithm of determination of athletes' fitness individual factorial structure and finding the players, who have the most similar fitness indicators

At first stage complex expanded athletes' testing is conducted, which includes: pedagogic tests, functional tests; biochemical indicators; indicators of nervous system's properties and speed of reaction. At second stage general structure of athletes' fitness if determined with factorial analysis (finding of principle factors). The procedure of factorial analysis permits to determine individual factorial values for every athlete. In our research it is finding of individual factorial values for every athlete. That is why we offer the next (third) stage in this algorithm. At third stage individual factorial parameters are determined. On fourth stage hierarchic cluster analysis of testing indicators is fulfilled. The athletes are divided into groups by degree of their indicators similarity. On fifth stage individual factorial values are considered. Basing on factorial values and cluster analysis athletes' individual characteristics are composed.

Let us provide some examples of application of first research direction's algorithm.

We fulfilled complex testing of elite basketball players by 26 pedagogic, psycho-physiological and biochemical indicators. The received data were processed with factorial and cluster analysis. Then, we built individual factorial models of players and worked out individual programs of basketball players' training.

For determination of fitness's individual structure, first it is necessary to find general structure of athletes' fitness. For this purpose factorial analysis was used. With the help of factorial analysis great number of variables (in our case – 26) was reduced to less quantity of independent values (factors).

In general structure of basketball players' fitness we marled out six factors (see table 1).

Complete characteristic of factors is given in table 1. Let us open the meaning of each factor.

In the first factor the following indicators entered: body length and mass, accuracy of penalty throws, absolute PWC_{170} value, minimal threshold of kinesthetic sensitivity.

It is not difficult to notice that body height, weight and absolute PWC_{170} value are naturally interdependent. It is natural that with increase of height, weight and strength absolute indicators also increase. Strength is manifested in indicators of PWC_{170} test, requirements of which raise with increasing of athletes' weight.

Accuracy of penalty throws is also connected with higher indicators of body mass and length. Taller athletes require less force to throw ball. That is why they have

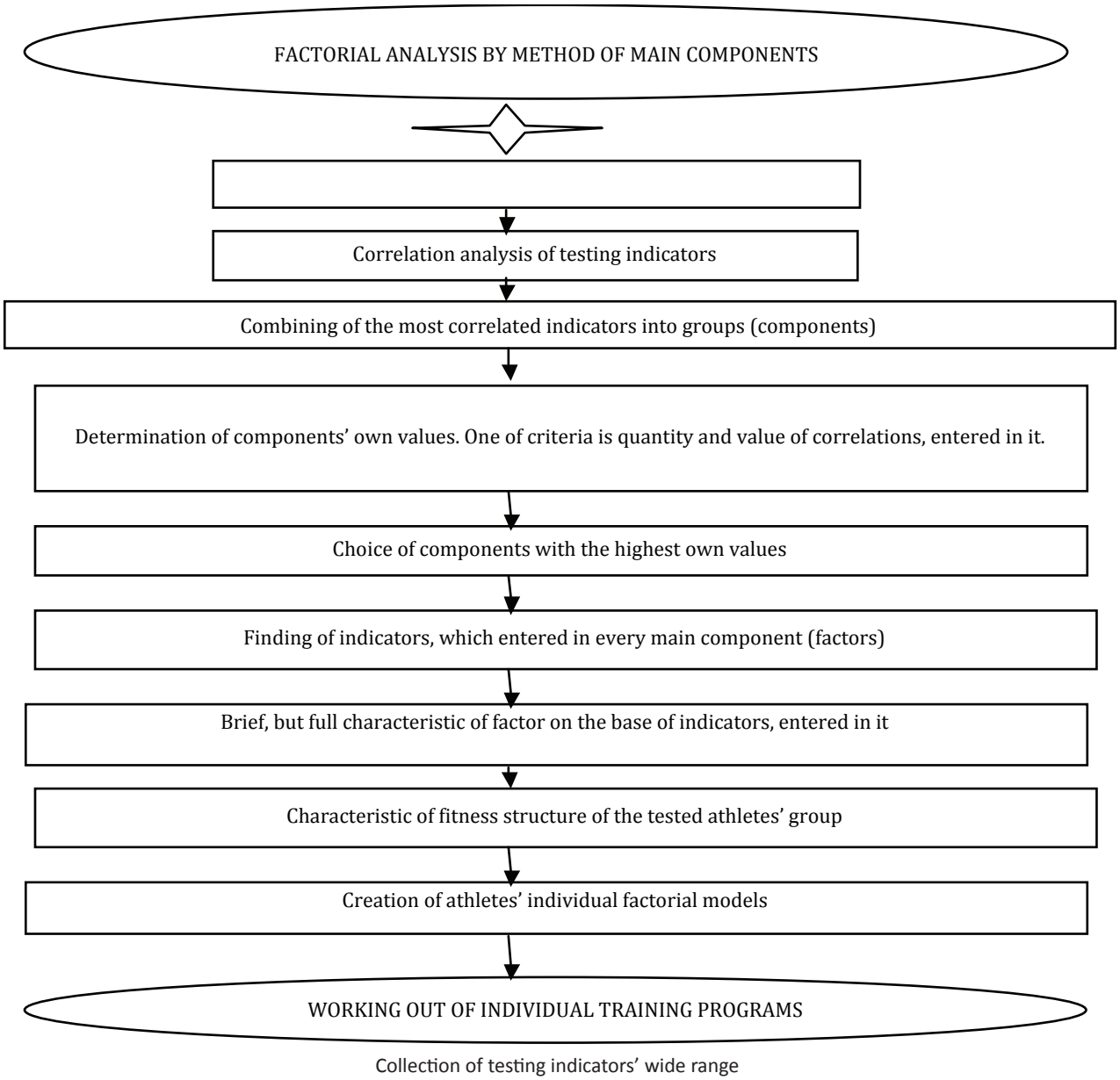

Fig. 3. Scheme of trainings' individual programs' development with the help of factorial analysis by method of main components

more opportunities to fine differentiation of force.

This factor also includes indicators of minimal kinesthetic sensitivity threshold. Kinesthetic sensitivity threshold increases with increasing of athletes' weight and height.

It is connected with the fact that with increasing of absolute muscular mass the felt minimal threshold of the hold weight also increases. The first factor included: speed jumping (quantity of jumps per 20 sec.) with negative coefficient of interconnection; time of shuttle run (sum of three attempts). These indicators worsen with increasing of anthropometric data. It corresponds to the delivered in the second part of theoretical conception of athletes' trainings' individualization.

Analysis of the first factor correlations shows that Indicators of jump from the spot are directly interconnected: the more is basketball players' body length the higher indicators of jump from the spot they have. The highest accuracy of penalty throws is also observed with the highest values of body length and jump from the spot.

With average values of body length and jump from the spot we observed the least accuracy of penalty throws and results of jump from the spot: indicators, which require sufficient level of physical condition's absolute indicators.

On the base of testing indicators' analysis (first factor) we characterized it as "morphological functional development".

The second factor included indicator of RR intervals' variation range in analysis of heart beats rate data. With increasing of RR intervals, variation range activity of para-sympathetic sector of nervous vegetation system in rest state also increases. It characterizes ability for relaxation.

Table 1. Factorial structure of basketball players' fitness (correlation coefficients more than 0.4 are given) (n=28)

Indicators	Components (factors)					
	1	2	3	4	5	6
Threshold of kinesthetic sensitivity (r)	0,97					
Body length (cm)	0,91					
Body mass (kg) Jumping for quickness (quantity of jumps	0,85					
per 20 sec.)	-0,84				0,40	
Jump from the spot (cm)	0,82					
PWC_{170} (kgm/min)	0,63		0,51	0,46		
Shuttle run, Sum of three attempts (sec.)	-0,62			-0,60		
Penalty throws (% of hits)	0,51					
Time of reaction to light (msec.)		0,95				
Time of reaction to sound (msec.)		0,95				
Variation range of RR intervals in indicators of heart beats rate (sec.)		-0,74				
Time of 6 meters' distance run (sec.)	-0,58	-0,61	-0,43		0,51	
Strength of nervous system by 12 points scale)		0,60			-0,48	
Concentration of hemoglobin in blood (g/l^{-1})			0,95			
Time of defensive moving (sec.)	0,43		-0,83			
Accuracy of throws from middle distance (%)			0,82			
PWC_{170} relative ($kgm/min^{-1} \cdot kg^{-1}$)			0,75			
Cortisol concentration in blood ($nmole/l^{-1}$)	-0,44		-0,73			
Time of 2•28m distance run (sec.)			-0,71	-0,52		
Tension index in heart beats rate (conv.un)		0,52	-0,58		0,44	
Jump from run (cm)				0,95		
Insulin concentration in blood ($nmole/l^{-1}$)		-0,41		0,85		
Throw of filled ball from the spot (m)			0,60	0,75		
Throw of filled ball from run (m)	0,54			0,66		
Mo in indicators of HBR (sec.)				0,65		
Cortisol concentration in blood ($nmole/l^{-1}$)					0,87	
Mode amplitude in indicators of HBR (%)				0,47	0,62	
Speed technique (sec.)		0,51				0,80
Tapping test (quantity of pressing per 1 sec.)			-0,53			0,75
Sum of factorial loads	7,00	6,90	5,58	4,71	4,56	3,23
Factor's contribution in total dispersion	35,48	29,94	14,30	9,76	5,67	4,83

Method of selection: analysis of main components;
Method of rotation: Varimax with Keiser's normalization;
Rotation was during 11 iterations.

The most precisely the second factor characterizes the following indicators: reaction to light and audio irritators; RR intervals' variation range. With increase of nervous system's strength RR intervals' variation range also increases. It can be noted that with increase of nervous system's strength ability for relaxation also increases. All these indicators are mutually conditioned.

This group of indicators reflects the strength of nervous system, its stability and ability for relaxation and was called "strength of nervous system".

The third factor included: accuracy of throw from middle distance; relative PWC_{170} indicator; Level of nervous system's functional potentials; hemoglobin and cortisol concentration in blood; tension index in heart rhythm; time of 2•28 m distance run. Test for accuracy of throws from middle distance is determined by speed-power endurance. Speed-power endurance is connected with relative indicator PWC_{170} and hemoglobin concentration in blood.

The third factor is characterized the most precisely by relative indicator PWC_{170}, hemoglobin concentration and accuracy of of middle distance throws. Indicators of PWC_{170} relative values and hemoglobin concentration are directly interconnected. The highest accuracy of middle distance throws was also observed at the highest hemoglobin concentration and indicators of relative PWC_{170}. At average values of hemoglobin concentration and average values of relative PWC_{170} we observed average of middle distance throws' accuracy. It can be noted that with increase of aerobic and anaerobic

workability accuracy of middle distance throws also increases.

Level of functional potentials conditions endurance of nervous system. That is why the third factor was called as "special endurance".

The fourth factor included indicators of jump from run, throw of filled ball (from the spot and from run), mode indicators (Mo) in heart rhythm, insulin concentration in blood. Jump from run, throw of filled ball are speed-power indicators. These indicators depended on many biochemical parameters, including insulin concentration.

Mode in heart rhythm reflects activity of humoral link of heart rhythm's vegetation regulation and indirectly – para-sympathetic sector of nervous system. This principle relates to those qualities, which are conditioned by creatine phosphate system of energy supply.

For fourth factor interconnection between *mode* indicators in heart rhythm, jump from run and insulin concentration are the most characteristic.

With increase of HBR in rest (i.e. with increase Mo) insulin concentration in blood increases: activity of organism's energy supply increases and speed power qualities improve.

That is why the fourth factor was called "speed-power qualities".

The fifth factor included: amplitude of mode in heart rhythm indicators; total quantity of pressing in tapping tests; cortisol concentration in blood. Cortisol concentration conditions adaptive potentials of organism and activity of sympathetic sector of vegetative nervous system. Mode amplitude and tension index in heart rhythm indicators condition activity of sympathetic sector of nervous system. On the base of data analysis the fifth factor was called "vegetative regulation of functions".

The sixth factor included indicators: "speed technique"; maximal frequency of pressing in tapping test. Basin on these indicators' analysis the sixth factor was characterized as "speed abilities".

Factorial analysis permitted to determine the structure of basketball players' fitness, which included six expressed factors:

- First factor – morphological functional development;
- Second factor – strength of nervous system;
- Third factor – special endurance;
- Fourth factor – speed power qualities;

Table 2. Examples of individual values of athletes' factors (main staff of team)

Athlete's №	Factors					
	1	2	3	4	5	6
1	-0,11	0,70	-0,02	1,67	-0,23	-1,34
2	0,56	-0,39	-0,86	0,39	1,86	0,57
3	1,03	1,14	-0,10	0,01	-0,99	1,34
4	0,00	-0,58	2,15	0,01	0,33	0,27
5	-1,96	0,79	-0,26	-0,68	0,21	0,34
6	-0,33	-1,75	-0,72	0,19	-1,17	0,20
7	0,82	0,10	-0,19	-1,60	-0,01	-1,37

Table 3. Fragment of agglomeration order in cluster analysis of basketball players' testing indicators

Step	Combining in clusters		Coefficient	Step at which cluster is the last		Next step
	Cluster 1	Cluster 2		Cluster 1	Cluster 2	
1	3	7	27,483	0	0	2
2	3	6	37,926	1	0	3
3	3	4	46,644	2	0	4
4	2	3	52,279	0	3	5
5	1	2	68,268	0	4	6
6	1	5	91,713	5	0	0

Table 4. Every athlete's belonging to cluster

Athletes	5 clusters	4 clusters	3 clusters	2 clusters
1	1	1	1	1
2	2	2	2	1
3	3	3	2	1
4	4	3	2	1
5	5	4	3	2
6	3	3	2	1
7	3	3	2	1

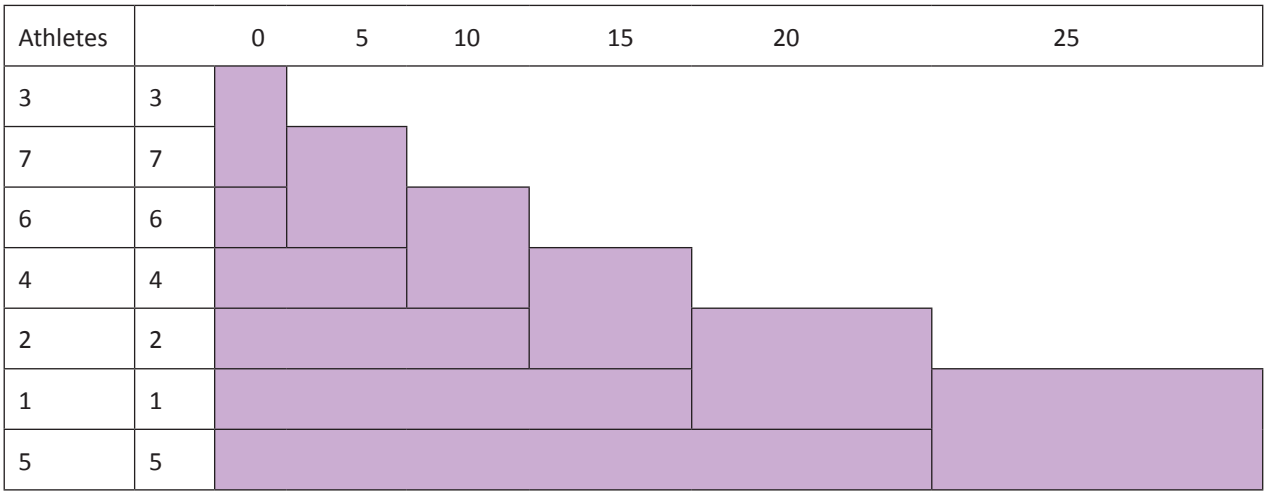

Fig. 4. Fragment of dendogram of athletes' combining in clusters.

- Fifth factor – vegetative regulation of functions;
- Sixth factor – "speed abilities".

Determination of basketball players' fitness' individual structure and specifying of their game functions For determination of basketball players' fitness' individual structure we calculated individual factorial values, presented in table 2. Every individual factorial value can vary from -3_to +3. In our study first factor (morphological functional development is the most expressed in athletes №№ 3 и 7 (see table 2, fig. 5). Second factor (strength of nervous system) is the brightest in athletes № 5 and 3. Third factor (special endurance) is the most expressive in athlete № 4; fifth factor (vegetative regulation of functions) – in athlete № 2, and sixth factor (speed abilities) – in athlete № 3 (table 2, fig. 5).

For specifying basketball players' game functions we used hierarchic cluster analysis of testing indicators. In hierarchic cluster analysis every separate case forms, first, own cluster. With every step two, the most close to each other separate clusters, combine in one cluster. The stages of combining in clusters are given in table 3. From tables 3 and 4 and from fig. 4 we can see that at first step players №№ 3 and 7 combined in one cluster.

From this it follows that theses players are the most close by their fitness structure. It shall be considered in trainings and games. For example these athletes can form pairs at trainings. These athletes can also replace each other in game and be on the site simultaneously, depending on the tasks of training.

Below there is example of calculation of clusters' optimal quantity:

- 7 (quantity of players) - 4 (№ step) = 3 (clusters).
- Cluster 1 – "central players" (athlete 1).
- Cluster 2 – "forwards" (athletes 3, 7, 6, 4, 2)
- Cluster 3 – "backs" (athlete 5).

At the next stage of cluster analysis athlete № 6 joins them. And so on.

For determination of clusters' optimal quantity it is necessary to deduct number of step, at which clusters start to grow in non-linear way from the quantity of analyzed athletes.

In our case it is step № 4 (see table 3, 4, fig. 4). That is why optimal quantity equals to 7-4=4.

So, we found 3 clusters: 3 groups of basketball players. In basketball it corresponds to 3 main functions of players: central players, wing forwards and backs. In fig. 4 we can see belonging of every player to definite cluster.

First cluster (central players) consists of athlete № 1. Second cluster) wing forwards) consists of athletes №№ 3, 7, 4, 6, 2. It should be noted that athlete № 2 joint cluster "wing forwards) as the last. That is why he can be regarded as player with transitive function between wing forward and central player. Third cluster (backs) consists of one player № 5 (see fig. 5).

Thus, as a result of cluster analysis we specified basketball players' functions that cause some difficulties in coaches' work with athletes, who have not expressed game roles. The received distribution corresponds to models of physical qualities' interconnection, presented in conception of individualization of athletes' training process. Central players have expressed factor "speed power qualities". Speed-power qualities are determined multiplying force by speed (F•V). Wing forwards have the most developed factor "special endurance" and "speed power qualities. Quickness is prevalence of V (speed) in multiplication force by speed. Special endurance in basketball is prevalence of product V•t (speed manifested during period of time). Backs have better speed abilities (V) and special endurance (V•t). Thus, we experimentally proved theoretical model of physical qualities' interconnection.

On the next stage of the research individual fitness factors and results of cluster analysis were combined and individual profiles of basketball players, with specifying their game functions, were created (see fig. 5).

Analysis of confidence of basketball testing results of different game roles by Student's t-test showed that more than 2/3 results are confidently different in different game roles basketball players in tests for physical and technical fitness and by biochemical and psycho-physiological indicators [26].

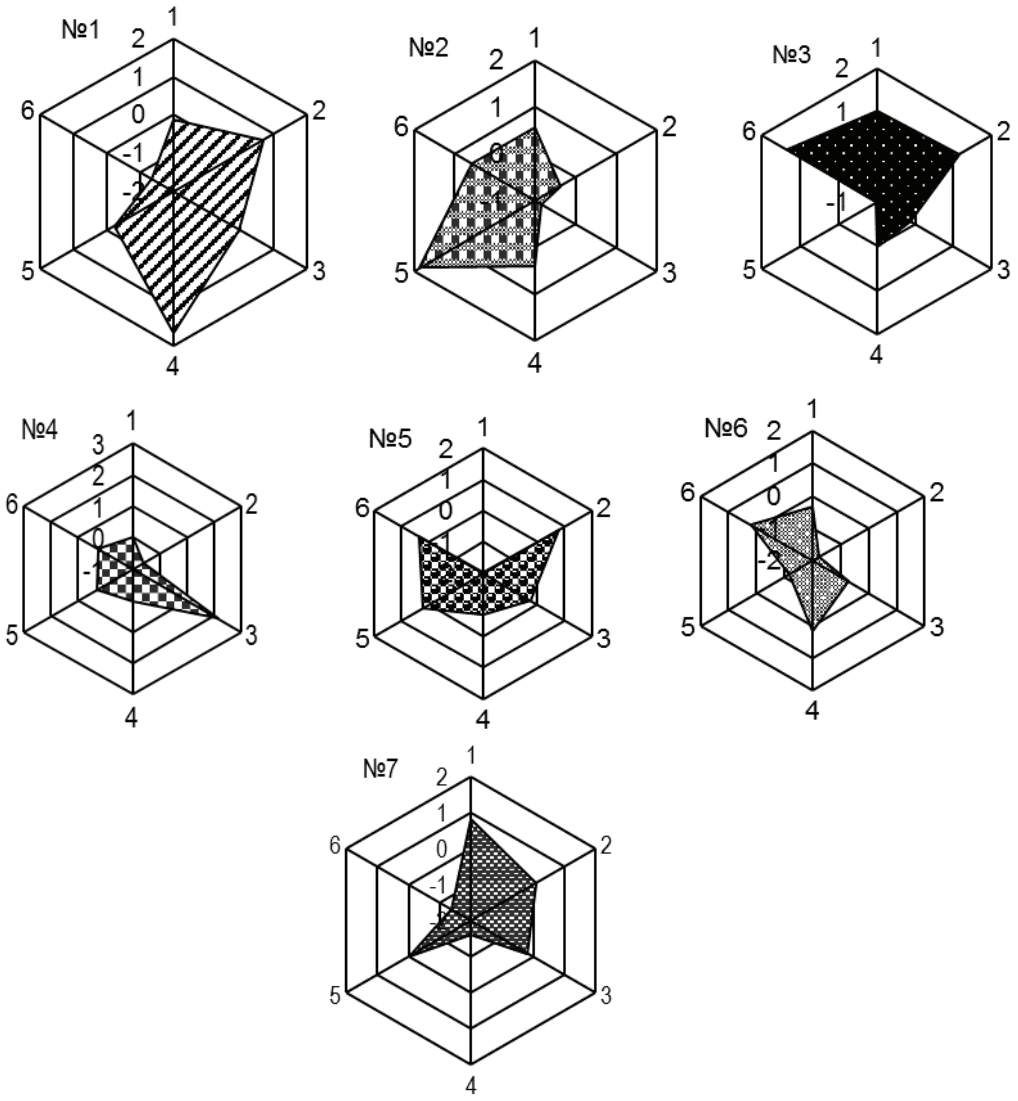

Fig. 5. Individual values of factors of athletes of team main staff: №№ 6,7 – forwards, №5 – back.
Names of the factors: 1 – morphological functional development; 2 – strength of nervous system; 3 – special endurance; 4 – speed power qualities; 5 – vegetative regulation; 6 – speed abilities (0 corresponds to average expressiveness of the factor); negative values correspond to factor's expressiveness below average; positive values – to level above average).

Discussion

Generalization of the received data and theoretical analysis permitted to formulate theoretical conception of individualization of athletes' training process [24, 26, 36]. According to this conception individualization system implies application of the following methods:

Method of determination of athletes' fitness structure and finding of leading factors in fitness structure;

Method of competition efficiency individual laws' determination, method of creation of individualization methodic, for athlete to open his potential.

The conducted study permits to characterize possibilities of practical application of means and methods' system for individualization of athletes' training process. When working out training individual programs development of leading factors in individual factorial structure shall be accented. For every athlete we found groups of leading and lagging factors in individual structure of fitness. Leading were the factors making in sum more than 50% in individual structure of fitness. The rest factors were lagging behind. For development of leading factors 60-80% of individual training were assigned and for lagging factors - 20-40%. Accent on leading factors' development increased with approaching to competition period. In competition period correlation of leading and lagging factors was 70:30.

When completing start staffs of teams (replacements in game, formation of pairs and "three" on trainings it is necessary to consider the data of cluster analysis about players' similarity and their division in groups. Depending on the tasks of training and peculiarities of definite game we formed acting groups, playing in concordance from "similar" players and from different athletes.

In individual structure of athletes' fitness we marked

out the factors with indicators, correlating with them. Besides, for individual training programs we composed distribution of means of physical, technical, tactic, game and psychological training.

The process of athlete's training shall contain basic and variable components. Basic component is 70% of means in general system of athletes' training. Variable component implies application of individual training programs. Variable component is 30% of means: is application of individual training programs. For athletes with prevailing development of factors, making approximate models of means distribution by kinds of training. Besides, the periods of biorhythms are considered. Percentage of means correlation in individual training programs varies depending on leading factor in individual fitness structure; period of individual dynamic of competition efficiency. In every micro cycleB 30% of time is assigned for players' individual training: athletes receive individual tasks; if necessary groups are formed on the base of cluster analysis data.

Carlsson and C. Lundqvist [8] regard the problem of individual distinctions exclusively from the point of psychological distinctions. With the help of factorial analysis the authors showed peculiarities of different behavior types of coaches in training and competition process. But they do not consider other psycho-physiological, physiological and morphological indicators of coaches and athletes. Most of psychological studies in sports do not touch individualization problem from the point of human state analysis as system, combining a complex of different indicators. That is why from this point of view our work is of certain novelty.

It should be noted that D. Conte et al. [11] try to give integral assessment of individuality, considering wide spectrum of indicators. The authors found influence of players' different quantity and trainings' regimes on motor load in basketball. 20 young basketball players fulfilled four game exercises in groups 2x2 and 4x4. Wide spectrum of physiological, subjective and technical indicators was registered. Physiological load was assessed by percentage of maximal heart beats rate (% HRmax) and subjective feeling of the endured load (RPE). Besides, the analyzed the following technical actions: dribbling, taking ball away, pick ups, losses total quantity, correct and wring actions, % неправоf total throws' quantity). The authors found that the most physically and technically loading are game exercises, fulfilled by 2x2. This conclusion was made on the base of data processing with the help of factorial analysis. The received by us data prove results of D. Conte et al. [11] about effectiveness of multidimensional analysis for complex assessment of fitness and effectiveness of training process's different regimes. However, the mentioned study did not imply determination of layers' individual characteristics. From this point of view our work is of certain novelty. From this point of view our work is of certain novelty.

In sport physiology and medicine individual distinctions are registered by peculiarities of reaction to load by cardio-vascular and nervous systems. Our conception permits to combine physiological and psycho-physiological indicators in single integral picture of athlete's individual portrait.

In sport games athletes are classified by functions – game roles. With recommendations for training of different game role players being available, the problems of individual distinctions (psychological, physiological and psycho-physiological characteristics) are practically not elucidated. That is why algorithms for determination of leading factors, offered by us include wide complex of analyzed indicators in the structure of athletes' fitness. Such direction seems to be a new approach to problem of athletes' trainings' individualization.

Working out of training process's individualization theoretical methodic principles is directly connected with the future of sport games. Construction of training process is significantly complicated by demand in study and application of individual approach to every player. However, it is the main requirement of modern sports. Individual approach is required by every player of different game roles and players of similar functions. Modern scientific methods permit to give exact characteristic of athletes' individual features and build the so-called "ideal" models of athletes. However such methods are seldom used. That is why effectiveness of training process weakens noticeably. Just because of it our approach is new and promising direction in theory and methodic of sports training.

J. Henderson et. al. [17] regard the problem of individualization from the point of athletes' genetic properties. The authors think that determining factor of sport successes if genetic one. They offer to use the data about structure of DNA in building training process and predicting athletes' success. However, the authors did not studied: on which base it is necessary to individualize load and plan individual trainings. In literature we did not find algorithms for complex, integral assessment of athletes' individual features. That is why the presented in our work approach is a new direction in theory and methodic of sport training.

Generalizing results of these works we can note that the offered by us algorithm for determination of leading and secondary factors in individual structure of athletes' fitness combines offers of the mentioned above authors and permits to quickly and effectively find athletes features.

Too many of talented athletes left sports, not opening all their potentials. They were trained by standard methods. Such system does not consider their individual features, functional reserves adaptation potentials. When specialists were able to realize individual training program, athletes achieved outstanding results. Sport training programs shall not be strictly determined. They shall be auxiliary materials for a coach or pedagogue but not the main manual.

In this connection it should be noted that principles, offered by us permit to avoid negative mass approach for athletes' training and permit for athletes to open their potentials completely.

Every talented athlete goes to the peak of sportsmanship to large extent by their own way. For some athlete such way is shorter and straight. The other has to go by winding and longer way. On all ways of sportsmen formation sport training's individualization significantly expands the circle of talented athletes. In this connection our work is a particular offer for seeking the way, required for athlete's individual realization.

Thus, in our research we expanded, integrated and specified the deducted by different authors the following principles of athletes' training's individualization:

Alive system (including man) has own specific reaction to changing environmental conditions. It also concerns organism in the whole and its separate organs, systems, tissues and cells;

Preparation for main competitions shall be built, considering individual features and reserve potentials of athletes;

Demand in creative approach to training process with compulsory feedback;

Need in training system, which would consider athletes' individual features, their functional reserves and adaptation potentials.

Conclusions

Results of our researches showed that creation of effective individual training programs of athletes requires application of multidimensional analysis of different aspects of organism's functioning. The main laws of athletes' or team development repeat general laws of complex systems' development in alive and not alive nature. For analysis of athlete as system and creation of individual training programs it is necessary to base on fitness structure. Algorithm of athletes' individual factorial structure's determination and finding of similar players in clued the following stages. On the first stage complex, expanded athletes' testing if conducted, which includes pedagogic tests, functional tests, biochemical and nervous system's indicators, speed of reaction. On the second stage general structure of athletes' fitness is determined with factorial analysis; determination of main factors and composing of characteristics. On third stage individual factorial parameters are found. On fourth stage hierarchic cluster analysis of testing indicators is fulfilled. As a result athletes are divided into groups by similarity of their parameters. On fifth stage (on the base of individual factorial values and cluster analysis) individual characteristics of athletes are composed. Application of individual training programs in combination with universal individualization methods will create preconditions for increase of competition functioning's efficiency.

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Conflict of interests

The author declares that there is no conflict of interests.

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