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STRUCTURE OF THE RELATIONSHIP BETWEEN PSYCHOPHYSIOLOGICAL INDICATORS OF PLAYERS IN MODERN VOLLEYBALL

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Abstract

The paper defines the relationship structure of setter players psychophysiological indicators in modern volleyball using factor analysis. It is found that this structure is composed of five orthogonal factors with total fraction 72,2% of the total variance of the study group. The most important components are the regulatory factor, cognitive, the adaptive response factor, athlete psycho-emotional state factor and neurodynamic factor.

Keywords: factor analysis; psycho-physiological condition of the athlete; psycho-physiological characteristics; volleyball athletes; highly qualified athletes; volleyball; psychophysiological condition; psychophysiological features of the body; tapping test.

Introduction: in the modern system of selection, sports of the highest achievements, among various components, psychophysiological researches occupy a leading place [5]. The psychophysiological characteristics that meet the requirements of a particular sport and affect the achievement of high sports results are important. The results of the literature research suggest that the basis of successful play activities of volleyball players are the main neurodynamic factors of higher nervous activity, which are innate, unchanged, and play an important role in determining

the characteristics of human behavior and psyche [4]. The complex of cognitive characteristics underlies the ability of volleyball players to tactical actions. One of the defining aspects of the successful implementation of the tactical pattern of the game is resistance to stressful situations, which are common in sports [3]. Some of the most important areas are the study and development of methods and techniques for diagnosing and regulating the mental state of athletes at different stages of training. [7]. Analysis of heart rate variability is a modern methodology and technology for studying and assessing the state of the body's regulatory systems, in particular the functional state of different parts of the autonomic nervous system. The structure of interrelations of psychophysiological indicators of volleyball players with the use of factor analysis is also determined in the work. It was found that this structure consists of five orthogonal factors, with a total of 72.2% of variance of the group of subjects. The most significant components are the regulatory factor, cognitive, adaptive response factor, the factor of psycho-emotional state of the athlete, and the neurodynamic factor.

Research methods: theoretical analysis of scientific and methodical literature and documentary materials; determination of neurodynamic and sensorimotor characteristics (computer complexes "Multipsychometer-05", "psychotest-NS".) Assessment of heart rate variability using a heart monitor "Polar RS-8000CX" and statistical program "Kubios HRV"; Methods of mathematical statistics [1].

The results of the study and their discussion: the problem of finding and training high-level volleyball players remains relevant. The player with the necessary set of special qualities was selected to master the role of a player in the long-term training of volleyball athletes at the stage of basic specialized training [6]. The analysis of the games of top echelon teams convincingly proves that the successful performance of the team largely depends on the psychophysiological condition of highly qualified players. We have discovered that this question had not been analyzed enough in volleyball [5].

Factor 1, with a total "weight" of 25.5%, has combined indicators of the state of the autonomic nervous system. Based on such association, the components were identified that shows the structure of psychophysiological features of volleyball players. They help to determine the specifics of professional players to the greatest extent. The set of indicators has the highest weight characterizing the state of the autonomic nervous system in the supine position and orthostasis.

The structure of psychophysiological characteristics of volleyball athletes

		Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Lüscher color test	working capacity	-0,086	-0,060	0,186	-0,708	0,065
	anxiety	-0,069	0,199	-0,150	0,794	0,290
	concentricity	0,114	0,217	-0,228	-0,784	-0,135
	vegetative ratio	0,107	0,197	0,120	0,912	0,096
	heteronomy	-0,028	-0,149	0,071	-0,864	-0,102
Setting patterns	productivity	0,117	0,795	0,101	-0,252	0,022
	efficiency	0,174	0,796	0,218	-0,161	0,243
Perceptual speed	productivity	0,062	0,754	-0,130	0,342	0,132
	efficiency	0,003	0,765	-0,013	0,287	0,226
Endurance	stability	0,349	-0,046	0,150	-0,019	-0,730
FMNP	maximum speed PI	-0,327	-0,374	0,104	-0,317	-0,759
	impulsiveness	0,331	-0,319	0,002	-0,108	0,778
Comparison of numbers	efficiency	0,025	-0,879	0,078	-0,101	0,300
	latent decision time	0,032	-0,870	0,075	-0,128	0,362
POLAR lying down	Mean RR	0,706	0,365	0,534	0,037	-0,105
	STD RR (SDNN)	0,964	-0,066	0,019	-0,121	0,120
	RR triangular index	0,892	-0,158	0,055	-0,192	0,256
	VLF	0,889	-0,004	0,128	0,225	-0,134
	LF	0,945	-0,106	0,026	-0,101	0,106
	HF	0,784	0,024	-0,194	-0,320	0,134
	Total	0,957	-0,005	-0,068	-0,134	0,085
	SD1	0,891	-0,041	0,035	-0,238	0,204
	SD2	0,966	-0,081	0,021	-0,072	0,090
	Shannon Entropy	-0,818	0,280	-0,056	0,406	-0,199
POLAR standing	Mean RR	0,449	0,149	0,833	0,134	-0,134
	STD RR (SDNN)	0,916	0,133	0,094	0,196	-0,194
	Mean HR	-0,452	-0,090	-0,842	-0,142	0,092
	RR triangular index	0,813	0,129	0,306	0,028	-0,147
	VLF	0,835	0,341	-0,030	0,121	-0,055
	LF	0,801	-0,086	0,091	0,219	-0,259
	HF	0,857	0,339	-0,024	0,030	0,066
	Total	0,912	0,219	0,012	0,159	-0,121
	SD1	0,906	0,236	0,203	0,126	-0,013
	SD2	0,908	0,120	0,086	0,205	-0,208
	Shannon Entropy	-0,128	0,181	-0,783	0,242	-0,127
	Approximate Entropy	0,032	-0,172	0,908	-0,214	-0,037
	Sample Entropy	0,010	-0,058	0,946	-0,016	-0,019
Sum of load variables		17,842	11,304	8,683	7,554	5,170
Contribution of the factor to the total		25,5	16,1	12,4	10,8	7,4

The most significant indicators of this factor are the background parameters of statistical, spectral and nonlinear values of heart rate variability: Mean RR (0.706), STD RR (SDNN) (0.964), RR triangular index (0.892), VLF (0.889), LF (0.945) , HF (0.784), TOTAL (0.957), SD1 (0.891), SD2 (0.966), Shannon Entropy (-0.818). The parameters of the response to the autonomic nervous system between the connecting players and the transition from lying to standing position are also of a high value: STD RR (SDNN) (0.916), RR triangular index (0.813), VLF (0.835), LF (0.801), HF (0.857), Total (0.912), SD1 (0.906), SD2 (0.908). It can be interpreted as a "state of the autonomic nervous system" or "regulatory factor" based on the characteristics of the components of the first factor.

Factor 2. The total contribution to the general variance is 16.1%. The main indicators are those that reflect the level of cognitive functions. This factor combines indicators of general cognitive abilities: performance (0.795) and efficiency (0.796) of the test "Establishment of patterns". Also a significant share are the parameters of the characteristics of perception: productivity (0.754) and efficiency (0.765) of the test "Perceptual speed". The parameters of cognitive function acquire a significant share. They study the features of thought processes: efficiency (-0.879), the latent period of decision-making (-0.870) of the test "Comparison of numbers". Based on the results of the analysis, the second factor can be interpreted as "state (level) of cognitive characteristics" or "cognitive factor".

Factor 3. The total contribution to the general variance is 12.4%. The system-forming indicators are the statistical parameters of heart rate variability in orthostasis (standing position) and the degree of organization (entropy) of the autonomic nervous system: Mean RR (0.833), Mean HR (-0.842), Shannon Entropy (-0.783), Approximate Entropy (0.908), Sample Entropy (0.946). The current activity of the sympathetic and parasympathetic divisions is the result of the reaction of a multi-circuit and multilevel system of blood circulation regulation. The blood system changes its parameters over time to achieve an optimally adaptive response that reflects the adaptive response of the whole organism [2]. The indicator of the organization makes it possible to assess the degree of the determinism of the probabilistic system in different conditions of the activity. The stochasticity of the functional system gives an opportunity to look for the necessary links to form the optimal level of organization. The defining parameters are the indicators that characterize the degree of the voltage of the regulatory systems in response to the functional load.

Factor 4 are the system-creating indicators that reflect the current mental state of the athlete (10.8%). The contribution to this factor is made by the indicators of the test of color choices: efficiency (-0.708), anxiety (0.794), concentricity (-0.784), vegetative coefficient (0.912), heteronomous (-0.864). The method of color choices shows not only the conscious, subjective attitude of the subject to color standards but also unconscious reactions to them. It confirms that the choice of color depends on both the current state and a set of stable personal characteristics associated with the constitutional type of individual. According to the results of the analysis, the fourth factor can be interpreted as "a factor of the psycho-emotional state of the athlete."

Factor 5. The total contribution to the general variance is 7.4%. The main indicators are the parameters of neurodynamic characteristics. This factor combines indicators characterizing the strength of the nervous system (stability - -0.730) and functional mobility of the nervous system (maximum speed of information processing - -0.759 and impulsivity - 0.778). The neurodynamic characteristics are the main determinants in the formation of human personality. The theoretical justification allows us to define it as a "neurodynamic" factor.

Also the tests were held that aim at determining the level of physical, technical and tactical preparedness and the testing of the psychophysiological state of volleyball players. For example, the tapping test was selected, as an express test, which includes performing the maximum number of pencil strokes in six squares of size 20x20 sm each for 30 seconds (5 seconds for each square separately without interruption). Analysis of the results of psychophysiological testing have provided a basis for determining the strength and the mobility of nervous processes of the surveyed players on the following indicators:

- maximum number of movements for a certain time interval (5 seconds);
- lability of nervous processes - the dynamics of changes in the number of strikes at regular time intervals (six intervals of 5 seconds each);
- time of single movement - the ratio between the maximum number of movements and the time of their use (5 seconds);
- the average value of the execution time of a single movement
- the ratio of the total number of movements and their execution time (30 seconds).

The obtained results have made it possible to establish the numerical values of the above indicators and gradation with grades "excellent - 5", "good - 4" and "satisfactory - 3". Analysis of

psychophysiological testing data showed that the score "excellent - 5" was received by 37 players, "good - 4" - 19 volleyball players, "satisfactory - 3" - 4 players. Therefore, it should be concluded that out of the 37 players who received an “excellent” test score, 31 players have the title of 1st adult category, 5 – CMS, and 1 - MS. 3 out of 4 athletes who took the test for “good” have the 1st adult category, the rest of the athletes play volleyball for recreational purposes and they do not have the experience of competition. The test results show that students whose psychophysiological condition is assessed as "good” and “satisfactory" have the potential to move from a weaker group in terms of physical, technical and tactical training to a stronger group in case of playing professional volleyball.

Conclusions and prospects for further research: in the course of research it was found that the structure of the relationship of psychophysiological characteristics of highly qualified volleyball players consists of five orthogonal factors with a total contribution of 72.2% of the general variance: factor 1 is interpreted as "regulatory" - 25.5%; factor 2 - "cognitive" - 16.1%. factor 3 - "adaptive response" - 12.4%; factor 4 - "psycho-emotional state of the athlete" - 10.8%; factor 5 - "neurodynamic" - 7.4%. Prospect for further research is the establishment of a link between the autonomic nervous system and individual typological properties of higher nervous activity of highly qualified volleyball athletes to further improve the training and competitive process in order to achieve a high sports result. The obtained data will allow us to implement the prognostic models directed on correction and individualization in the course of preparation and improvement of the sports skills of highly skilled volleyball players in the system of operative control. The analysis of the conducted researches have confirmed the relationship between the level of physical and technical fitness of volleyball athletes, with the level of manifestation of psychophysiological features of their body.

However, taking into account the interdependence of these processes, it should be noted that the results of psychophysiological testing provide an opportunity to make more detailed analysis of the level of physical preparedness and the degree of psychological reactivity of athletes with the possible usage of the data as practical recommendations and substantiation for the system of selection and training of volleyball athletes.

The prospect of further research is the possibility of using psychophysiological testing to predict the possible level of physical and technical training of athletes, as well as to conduct

operational, current, and stage-by-stage control of the dynamics of changes in the effectiveness and efficiency of volleyball classes of highly qualified athletes.

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