

## Relation of the competitive activity effectiveness of volleyball players (girls) at the age of 16-18 with the physical development indicators

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### Abstract.

*Aim:* To determine the impact of different indicators of physical fitness on the competitive activity effectiveness of volleyball players (girls) in the stage of preparation for higher achievements. *Material:* 22 volleyball players (girls) aged 16–18 participated in the study.

*Results:* significant influence of special physical fitness indicators on the competitive activity effectiveness of volleyball players (girls) at the stage of preparation for higher achievements was established. A high level of correlation was found between the performance of the ball reception after delivery and the speed of the subjects. Significant positive relationships were found between the performance of this techno-tactical action and the speed-power capabilities, the flexibility, and the ability to control the space-time and dynamic parameters of the movements. Intermediate level correlations are found between the effectiveness of volleyball players (girls) attack performance and speed and power capabilities, flexibility, explosive shoulder strength, and mobility in athletes' shoulder joints. The number of effectively performed defensive actions of volleyball players (girls) in official games has reliable mid-level relationships with the speed and speed-power capabilities, ability to kinesthetic differentiation, and speed endurance. A high level of correlation is found between the effectiveness of body blocks from the opponent's hits and the rate of standing vertical jump. Reliable low- and medium-level relationships were found between this techno-tactical performance of volleyball players (girls) and indicators of speed, agility, and endurance. A close relationship is found between the delivery quality and the ability to evaluate and differentiate the space-time and dynamic motion parameters.

*Conclusions:* The level of special physical fitness significantly influences the effectiveness of technical and tactical actions of volleyball players (girls) aged 16-18 in the conditions of competitive activity. High efficiency of competitive activity of volleyball players (girls) at the stage of preparation for higher achievements is impossible without the appropriate level of development of speed, agility, speed-power abilities, special endurance. Selection of special exercises and dosage of training load taking into account the individual characteristics of volleyball players (girls) will positively influence the competitive activity results and will allow to avoid health problems.

**Keywords:** volleyball players (girls), preparedness, competitions, abilities, correlation.

### Introduction.

Setting the purpose and objectives of the volleyball training process at a particular stage of athletic improvement of athletes is possible on the basis of a clear idea of what abilities and level of their development are required for each athlete to achieve relevant sports results. The level of athletic achievement in volleyball depends on the athlete's technical, physical, psychological and tactical preparedness. However, according to Paz et al. (2017), Kozina et al. (2018), in order to demonstrate high athletic performance, it is important not only to achieve a certain level of development of these components, but also to ensure their integral manifestation in the competitive process. The number of different manifestations of individual motor skills in volleyball is quite large. Therefore, the development and improvement of each of them requires adequate scientific support. In the volleyball process there is always a problem of quick response to the unexpected actions of the opponent. A high manifestation of speed-power qualities during the execution of certain techniques of the game is also required. Gjinovci, Idrizovic, Uljevic, & Sekulic (2017) state that modern volleyball game is also characterized by rapid movement, rapid orientation, attack and defensive actions in the severe time constraints and complex interaction with teammates.

Hnatchuk, Lynets, Khimenes & Pityn (2018), Malikova, Doroshenko, Symonik, Tsarenko, & Veritov (2018) indicate a direct relationship between the physical (functional) and technical and tactical preparedness of volleyball players (girls). Researchers in particular state that it is impossible to perform technical moves without demonstrating a high level of functional preparedness. The development of physical qualities results in a parallel improvement in technical preparedness. And, accordingly, the decrease in physical condition results in a decrease in the efficiency of performing technical moves in the competitive activity process.

Zaciorskij and Kraemar (2006), Platonov (2017) point out that physical training is a process aimed at developing the motor (physical) qualities and capabilities of functional systems. The authors identify five types of physical qualities – strength, speed, agility, flexibility, endurance. Researchers state that these definitions of physical qualities are generalized. In the real world of training and competitive activity, these qualities have a large number of relatively independent manifestations due to one or another ability. For example, they distinguish maximum and high-speed force, explosive and starting force, general and special endurance, power and high-speed endurance, etc. Therefore, each of the motor qualities should be considered as a set of physical abilities with a decisive role of one of the components – power, speed, coordination, energy supply, etc.

Mayberry, Patterson, & Wagner (2018), Fathi et al. (2019) emphasize that the principle of maximization should be applied to physical qualities that play a leading role in volleyball. That is, they should be developed to the maximum possible level for each athlete. It is advisable to apply the harmonization principle for physical qualities that play a supporting role in volleyball. That is, these qualities should be developed to a level that would not limit the manifestation of motor skills that are the most important in volleyball (Kozina, Iermakov, Bartík, Yermakova, & Michal, 2018).

Physical training of the volleyball player should not only create the necessary level of motor skills needed for the formation of effective technique and tactics, but also ensure their development on a wide range of skills that are related to this sport. This will allow to organically link fitness with motor memory, providing the basis for the manifestation of physical qualities in a wide variety of motor actions characteristic of competitive activity in volleyball. The wider the range of special exercises and motor actions is, the more favourable are the prerequisites for the formation of new forms of motor activity and the improvement of the previously learned ones. The combination of physical and technical training processes ensures that the relationship between the athletic technique and the qualities of volleyball players (girls) is organic. Also, the use of the combined influence method promotes the level of realization of physical fitness in competitive activities (Boichuk et al., 2018; Poperekov, Buldakova, Bandakov, Zhilina, & Solgalov, 2018). If the process of physical training of volleyball players (girls) is built taking into account the laws of age development, then athletes have a real opportunity to fully realize the natural abilities and achieve high sports results. If these laws are violated, then the young athletes do not reach the level of sportsmanship available to them. And, there will be the likelihood of disruption of the natural course of age development, the likelihood of serious diseases and pathological processes (Veremeenko, Khudolii, & Ivashchenko, 2019).

According to Ivashchenko et al. (2017) and Platonov (2017), athletes are particularly vulnerable in this respect. Unfortunately, in most cases, training of athletes (girls) is based on the same principles as those for athletes (boys). However, by this time, a large amount of knowledge has been accumulated in sports science, which points to the need for differences in the training of men and women. These differences are so significant that it is difficult to ensure a highly efficient process of physical training for volleyball players (girls) without their consideration. This can seriously disrupt the age-old development of athletes (girls) and harm their health. The differences should cover the structure, capabilities and features of the most important functional systems functioning, the level of motor qualities and features of their development. It is also necessary to take into account hormonal status, hyperandrogenism, women's sports triad and menstrual cycle, gender identity, mental characteristics and behavioural responses of athletes (girls).

Aoki et al. (2017), Trajkovic, Kristicevic, & Sporis (2017) state that such physical qualities as strength (explosive maximum, fast), speed (in all its manifestations), agility, coordination, endurance play a key role in volleyball. Researchers distinguish between static and dynamic forces and recommend developing both. In their view, maximum static force is required for individual joint angles (usually the beginning of movement). However, in the course of training such static exercises and modes of training load should be chosen that would be identical or very close in all parameters to the competitive exercise.

Zaciorskij and Kraemar (2006) pay special attention to the need to select special exercises that are close in shape and dynamic characteristics to competitive in the process of development of the speed-power qualities of volleyball players (girls). These exercises are recommended to be performed with great weight and in slow motion. Gradually, the pace increases, and the magnitude of the weight decreases. At the end of such a series, the athlete is tasked with performing a special exercise in lightweight conditions faster and more powerfully than he or she performs a competitive exercise. Only in this case, according to the researchers, there is a positive transfer of training from ancillary special exercise to competitive.

Combined and consistent loads with different predominant orientation of training influence are considered effective in the organization of physical training of volleyball players (girls) (Zaciorskij & Kraemar, 2006). In this case, preloads create a morpho-functional basis for effective impact of subsequent loads on the

athlete's body. Thus, there is a contradictory situation between the need to increase the level of fitness of volleyball players (girls) aged 16-18 as a prerequisite for improving their technical and tactical skills on the one hand, and insufficient scientific development of methodological support to solve this pedagogical task on the other one. This determines the practical and scientific relevance of the study problem.

*Hypothesis.* It is assumed that determining the effect of physical fitness indicators of volleyball players (girls) aged 16-18 on the quality of the technical methods of volleyball performance will improve the training process effectiveness. This approach will improve the competitiveness of players.

*Study purpose* is to determine the impact of different physical fitness indicators on the competitive activity effectiveness of volleyball players (girls) in the stage of preparation for higher achievements.

### **Material and methods.**

*Participants.* The experiment involved volleyball players (girls) who are in the stage of preparation for higher achievements (n = 22, age: 16-18). The study protocol was approved by the Ethics Committee of the Ivano-Frankivsk National Technical University of Oil and Gas.

*Study organization.* In the first study stage, comprehensive advanced testing of players' motor abilities was conducted. We used the speed, flexibility, speed-power qualities, special endurance, coordination abilities indicators to evaluate the motor abilities of athletes (girls). In the second stage, a study of the competitive activity of subjects was conducted. To determine the effectiveness of volleyball players' (girls') competitive activity, we used pedagogical observation. A total of 10 games were analyzed for each of the subjects. In the course of analysis of competitive activity we recorded the following indicators:

1. Number of ball receptions after delivery;
3. Number of goals missed;
4. Effectiveness of ball receptions after attacking strikes in the protection zone;
6. Missed spikes;
7. Successful protection of the court against fraudulent actions of the opponent;
8. Number of successful spikes;
9. Number of successful ball blocks from the opponent's spikes;
10. Number of successful ball deliveries completed.

*Tests to assess the level of physical qualities development.*

*Test 1:* Volleyball players' (girls') speed endurance was assessed using the "92 m running with changing direction" test (Fir tree test) (Boichuk et al., 2018; Zhelezniak, Portnov, & Savin, 2001).

*Determination of the speed of volleyball players (girls) (test 2-3).*

*Test 2:* "9-3-6-3-9 m running" (Boichuk et al., 2018; Zhelezniak, Portnov, & Savin, 2001).

*Test 3:* "3x10 m shuttle running around stuffed balls" (Boichuk et al., 2018; Lyakh, Sadowski, & Witkowski, 2011).

*Determination of the level of speed-power abilities (test 4-6).*

*Test 4:* "Standing vertical jump" (Boichuk et al., 2018; Serhienko, 2013).

*Test 5:* "Running vertical jump". The testing procedure was similar to the previous test. Before jumping out, the athlete performed a three-step run (Boichuk et al., 2018; Serhienko, 2013).

*Test 6:* "Standing long jump". (Boichuk et al., 2018; Serhienko, 2013).

*Test 7:* 2 Kg Overhead Medicine Ball Throw (MBT): Subject stands behind the starting line with feet slightly apart in line with shoulders, then he throws 2 kg of medicine ball overhead. Two tests are reported and the longest distance is reported in cm. This test evaluates the upper limb strength (Morrow et al., 2005).

*Test 8:* Finger-tip push-up for 10 s. The test equipment included a level wooden playground. The test participant acquires a lying position, arms are straightened and spread shoulder width apart with the hands forward. The trunk and legs form a straight line, the toes of the feet rest on the floor. On command, the participant can begin to bend and unbend his/her arms rhythmically with full amplitude. The result was an unmistakable flexion and extension of the arms for 10 seconds (Serhienko 2013).

*Determination of the flexibility development level (test 9-10).*

*Test 9:* Determination of the spinal column flexibility (Boichuk et al., 2018; Serhienko, 2013).

*Test 10:* To determine the level of mobility in the shoulder joints, the test "stick exercises" was used (Serhienko, 2013).

*Determination of the coordination abilities development level (test 11-13).*

*Test 11:* assessment and measurement of the magnitude of muscle effort was measured using a wrist medical dynamometer. The subject in a standing position and arms extended to the side carried out the maximum force. In the next three attempts, she was given the task of measuring the value of (0.5) from the maximum given value, which in inverse proportion characterized the accuracy of the estimation and measuring of efforts (Serhienko 2013).

*Test 12:* the ability of the subjects to kinesthetic differentiation was assessed using the test "Ball throw at the target with ones back to it" (Boichuk et al., 2018; Lyakh, Sadowski, & Witkowski, 2011).

*Test 13:* To determine the level of manifestation of motor coordination of volleyball players (girls) in cyclic locomotions, the “4x9 m shuttle running” test was used. The test equipment included a stopwatch, two wooden cubes, a 9-meter-long track. On command “At the Start”, the test participant takes a high start position in front of the start line. At the command “March” the athlete runs 9 m to the second line at the maximum pace. She takes one of the two wooden cubes lying on the line, runs backwards and puts it on the start line (the cube cannot be thrown). Then she runs back again, returns with the second cube and puts it on the starting line. This completes the test. The test result is the time recorded with an accuracy of 0.1 s from the start to the moment when the participant put the second cube on the line (Serhiienko 2013).

*Test 14:* Spatial orientation tests were assessed using the test “Running to numbered balls” (Boichuk, Iermakov, Podrigalo, Bezyazychnyy, 2018; Lyakh, Sadowski, & Witkowski, 2011).

*Statistical analysis.* The data obtained were processed using the statistical computer program SPSS 17. Multiple correlation analysis was performed.

## Results.

The analysis of scientific and methodological literature and program documents allowed us to determine the range of special physical fitness indicators that determine the effectiveness of volleyball players’ (girls’) competitive activity. However, the results of the correlation analysis indicate the different significance of these indicators for the qualitative performance of volleyball players (girls) in the process of competitive activity. Thus, the correlation matrix analysis (Table 1) shows that the number of effectively performed ball receptions after delivery has a close positive relationship with speed abilities. An even closer relationship was found between ball reception performance and 3x10 m running ( $r = 0.85$ ,  $p < 0.01$ ). In addition, we have established a positive relationship of low level between this technical and tactical action and the speed-power capabilities of the subjects. The indicator of angle body from the sitting position that characterized the flexibility of volleyball players (girls) also has a reliable low-level relationship with the ball reception performance after submission. Reliable mid-level relationships were found between the percentage of successful ball receptions performed after delivery and the ability to control the space-time and dynamic motion parameters ( $r = 0.59$  to  $r = 0.65$ ,  $p < 0.05$ ). Closer correlation was found between the quality of this technique and the ability to exhibit motor coordination in cyclic locomotions, which was manifested in the running to numbered balls ( $r = 0.54$ ,  $p < 0.05$ ) and 4x9 m shuttle running ( $r = 0.77$ ,  $p < 0.01$ ). The closest correlation was found between this measure of volleyball players’ (girls’) technical and tactical skill and their ability develop speed, which was shown in the test “Fir tree” ( $r = 0.84$ ,  $p < 0.01$ ).

Table 1. Relationship between volleyball players’ (girls’) physical development and competitive activity performance indicators

Physical development indicators	Competitive activity performance indicators				
	Ball reception	Attack	Defensive play	Body block	Delivery
9-3-6-3-9 m running, s	-.718*	-.603	-.561	-.690*	-.108
3x10 m shuttle running around stuffed balls, s	-.852**	-.580	-.726**	-.583*	-.516
Standing vertical jump, cm	.455	.602*	.331	.709*	.408
Running vertical jump, cm	.474	.583*	.330	.699**	.389
Standing long jump, cm	.412	.496	.577*	.528*	.375
Stuffed ball throw, cm	.671*	.500	.458	.388	.409
Push-ups for 10 s	.589*	.434	.514*	.147	.190
Sitting angle body, cm	.397	.430	.139	.290	.754*
Flexibility in the shoulder joint, cm	.403	-.482	.469	-.315	-.159
Handgrip test, kg	.246	.085	.070	.187	-.273
Muscle effort assessment, kg	-.654*	-.519	-.502*	-.186	-.575*
Ball throw at the target with ones back to it (differentiation of movement parameters), number of hits	.585*	.329	.366	.384	.557*
Running to numbered balls, (orientation), s	-.544	-.244	-.282	-.482	-.007
4x9 m shuttle running, s	-.771**	-.450	-.704**	-.348	-.510
92 m running with changing direction, s	-.835**	-.743*	-.681*	-.662	-.410

\*. Correlation is significant at the 0.05 (2-sided).

\*\*.. Correlation is significant at 0.01 (2-sided).

The volleyball players’ (girls’) attack performance indicator has reliable relationships of medium level with speed ( $r = 0.60$ ,  $p < 0.05$ ) and speed-power abilities ( $r = 0.43$  to  $r = 0.60$ ,  $p < 0, 05$ ). Close-to-meaningful correlation is found between this techno-tactical action of volleyball players (girls) and indicators of spine

flexibility and mobility in the shoulder joints. Low- to medium-level correlations are found between this indicator and the subjects' coordination abilities. The number of effectively performed defensive actions of volleyball players (girls) in official games has reliable correlation of the average level with the performance indicators of volleyball players (girls) (9-3-6-3-9 m running) ( $r = 0,56, p < 0,05$ ), (3x10 m running ( $r = 0.73, p < 0.01$ )). The effectiveness of this technical and tactical action has significant correlations with the indicators of standing vertical jump, running vertical jump, standing long jump, throwing a stuffed ball for a distance, fingertip push-ups for 10 seconds. The above indicators characterize the speed and power of volleyball players (girls). The performance indicator of technical and tactical actions in the protection of volleyball players (girls) has a reliable positive relationship with the ability to control the spatial, temporal, force parameters of movements, special endurance of volleyball players (girls) (from  $r = 0.37$  to  $r = 0.68, p < 0.05$ ). This technique is most closely linked to volleyball players' (girls') ability to locally coordinate in cyclic locomotions ( $r = 0.70, p < 0.01$ ).

Percentage of blocking performance has a reliable relationship between low and medium levels of coordination skills and the special endurance of volleyball players (girls). Closer relationships were found between the quality of this technique and tactical performance of volleyball players (girls) ( $r = 0.58$  to  $r = 0.69, p < 0.05$ ). The high level of correlation this technique has with the indicators of standing vertical jump ( $r = 0.71, p < 0.01$ ), and running vertical jump ( $r = 0.70, p < 0.01$ ), which characterized speed-power qualities of volleyball players (girls). Volleyball players' (girls') speed and power performance indicators also have low and medium levels of correlation with the ball delivery performance. Closer relationships are found between the quality of delivery performance and the ability to evaluate and differentiate space-time and dynamic motion parameters, flexibility ( $r = 0.56$  to  $r = 0.75, p < 0.05$ ).

### **Discussion.**

The results of our study confirmed the hypothesis that a significant number of reliable relationships exist between the physical and technical and tactical fitness indicators of volleyball players (girls) aged 16-18. As it is known (Boichuk et al., 2018; Mytckan, et al., 2018), modern volleyball is characterized by high movement activity of volleyball players (girls). Most tactical combinations are based on speed of response and speed of movement. The multiple repetition by the volleyball players (girls) of technical and tactical actions in the course of the game requires to a great extent the manifestation of all motor qualities and their combinations (Zerf, Louglaib 2019). Analyzing the results of correlation analysis, we should note a significant number of correlations between the performance of the ball reception and the many indicators studied. In our opinion it is natural. After all, as it was reported by Malikova, Doroshenko, Symonik, Tsarenko, & Veritov (2018), the successful ball reception after delivery depends on the level of physical fitness of the players. They should be able to be in a semi-squat for a long time, quickly move around the court. The high level of correlation between the quality performance of this techno-tactical action and the manifestation of speed and agility in volleyball players (girls) can be explained by a significant increase in the delivery power in modern volleyball. Volleyball players (girls) tactically combine a planned delivery in a jump and a shortened delivery. This requires timely response, determination of the ball flight path, and rapid movement for quality performance of this technique. The results of our study confirmed the data of other authors (Hnatchuk, Lynets, Khimenes & Pityn, 2018; Frolova et al., 2019) on the importance of specialized perceptions (perception of a ball, a partner, a net, a playground) to achieve high volleyball sports results. Researchers point out, in particular, the need for the systematic inclusion of special exercises in the training process of volleyball players (girls) for purposeful improvement of these functions. The close relationship between the speed endurance indicator and an effective game in defense and in attack has confirmed the importance of this quality for the successful competitive activity of volleyball players. According to Mytckan, et al. (2018), Soyal, Kaya, & Çelik (2019) a high level of speed endurance allows volleyball players to perform techniques and movements with high speed throughout the game without compromising efficiency.

In the course of the study, we found a reliable relationship between the speed of volleyball players (girls) and the attack action performance. This can be explained by the fact that modern volleyball is characterized by a significant increase in the game intensity by increasing the speed of attack development, and use of back-line players in the attack. The relationship we find between the spikes performance and the speed and power capabilities of volleyball players (girls) is consistent with the data of other authors (Aoki et al., 2017; Mayberry, Patterson, & Wagner, 2018). Researchers point out, in particular, that the spike performance is interconnected with the strength of the extensors of the lower leg, thigh, trunk, jumping ability, dexterity, speed of the starting reaction and speed of the 3 m segment. Positive interconnections of low and medium levels between the flexibility indicators of volleyball players (girls) and almost all motor actions confirmed by other researchers (Hnatchuk, Lynets, Khimenes & Pityn, 2018). These authors indicate a manifestation of flexibility in performing all the technical techniques of playing volleyball. At the same time adding that, good mobility in the joints contribute to the high-quality performance of technical elements.

The performance of technical and tactical actions in defense has a reliable relationship with the speed, speed-power, coordination abilities of volleyball players (girls). The interdependence between the effectiveness

of these actions and the flexibility and special endurance indicators were also revealed. The data we have obtained are fully consistent with the study of scientists on the theory and methods of sports training in volleyball. These experts indicate that the motions during the defense game are high-speed (instant starts, acceleration, fall) and precision-coordination (accurate reception, ball transfer). Effective performance of this type of activity is ensured by a high level of speed, agility, accuracy of differentiation of musculoskeletal and visual-vestibular sensations (Kozina et al., 2018).

The studies also showed that an important reserve for increasing the body blocking efficiency is a high level of development of speed, standing vertical jump, spatial orientation and special endurance. As experts (Gjinovci, Idrizovic, Uljevic, & Sekulic, 2017) state, the key points of effective body blocking are anticipation (forestalling), decision making, moving speed and jumping abilities. Timing (time-point selectio) is also key to effective blocking. The jump should be estimated so that the blocker jumps immediately after the attacker's jump, depending on how far the attacker is from the net.

When speaking about the ball delivery, performance, then our findings are in line with previous findings by other authors (Hnatchuk, Lynets, Khimenes & Pityn, 2018; Malikova, Doroshenko, Symonik, Tsarenko, & Veritov, 2018) on the important role of high levels of special physical fitness. preparedness for the successful implementation of this technical and tactical action. We believe that it is natural. Because in modern volleyball, delivery is not only a way of introducing the ball in the game, but also a highly effective attacking action, which is a powerful and effective means of overcoming the opponent's defense in order to achieve a positive game result.

Thus, the data we obtained allowed us to investigate the peculiarities of the relationship between the fitness and the competitive performance indicators of volleyball players (girls) in the training for higher achievements. A large number of reliable positive relationships showed a direct dependence of the technical and tactical skills of volleyball players (girls) on the level of physical qualities development. The great importance of speed, explosive strength, coordination abilities and special endurance in the structure of physical fitness of volleyball players (girls) aged 16-18 is confirmed in comparison with other motor abilities. Along with this, further study is required to develop training tools to increase the level of special physical fitness, which are similar in form and dynamic characteristics to the main technical methods of playing volleyball. Undoubtedly, such special exercises significantly affect the improvement of technical and tactical skills of volleyball players (girls). It seems that it is time to pay more attention to the development of methodological recommendations for drawing up individual programs for the physical training of volleyball players (girls), taking into account the laws of age development, physique, level of physical qualities, such as the nervous system, game role.

### Conclusions.

1. The results of the correlation analysis suggest that the level of special physical fitness significantly affects the effectiveness of the technical and tactical actions of volleyball players (girls) aged 16-18 in the conditions of competitive activity. Of the 80 calculated correlations between players' fitness levels and the effectiveness of their technical and tactical actions, 60% of significant positive relationships of all the considered were established.

2. Indicators of speed, speed- strength abilities, dexterity, coordination, speed endurance have a reliable relationship with almost all the technical and tactical techniques that have been studied. High efficiency of competitive activity of volleyball players (girls) at the stage of training for higher achievements is impossible without proper development of these motor qualities.

3. The study confirmed the need for a highly effective process of physical training of athletes in modern volleyball. Selection of special exercises and dosage of training loads, taking into account the patterns of age-related development of volleyball players (girls), physique, female body characteristics, mental characteristics and behavioural reactions, have a positive effect on the results of competitive activities of athletes. Also, this will allow volleyball players (girls) to avoid health problems and developmental disorders.

### Conflict of interests

The authors declare that there is no conflict of interests.

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