

Original Article

Improving the functional preparedness of volleyball players aged 18–22 using recovery measures

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Abstract.

Studies that conducted on the women's volleyball material show that one of the main reasons for the unsuccessful performances of Ukrainian athletes in this sport is the inability to maintain the optimal level of functional preparedness for a long time. **The purpose** is to optimize the functional preparedness of female volleyball players aged 18-22 during the competitive period in the annual training cycle using antioxidant recovery measures. **Methods:** analysis and generalization of scientific and methodological sources; pedagogical observations; pedagogical experiment; testing of physical performance, aerobic capabilities, functional preparedness; functional methods of investigation cardiovascular and antioxidant (nitric oxide synthesis system) systems; methods of mathematical statistics. **Results.** At first developed the program of recovery measures of antioxidant nature for the volleyball players aged 18-22 during the competition period, which considered the correlation of players' functional preparedness level and their nitric oxide synthesis functional condition level, could be recognized as a modern one. The author's program of recovery measures, which additionally included the use of ecdysterol, allowed to significantly ($p>0.05$) increase the level of functional capabilities of female volleyball players. **Conclusions.** Using the recovery activities author's program designed for volleyball players during competition period in the annual training cycle contributed to substantial optimization of functional preparedness and other components of examined female athletes' fitness. The main positive changes were established in physical and aerobic performance, alactate and lactate capacity and volume, anaerobic metabolism threshold, heart rate at PANO, general metabolic capacity, efficiency system of muscular activity energy supply, reserve capacities, levels of general, speed, and power endurance, functional readiness, heart rate efficiency, adaptation capacity of the cardiovascular system, increase in the brachial artery diameter, linear and volumetric blood flow velocity and lower values of the total peripheral vascular resistance, tension index of regulatory mechanisms of the circulatory system and index of vegetative balance.

Keywords: competitive period, training, antioxidant, optimize, female, system.

Introduction.

The current level of the high sport achievements development puts high requirements to the athletes' fitness level in various kinds of sport activities (Andrade, Bevilacqua & Coimbra, 2016; Debien, Mancini, Coimbra, de Freitas, Miranda & Bara Filho, 2018; Doroshenko, Sushko, Koryahin, Pityn, Tkalic & Blavt, 2019). Today achievement of high sports results is impossible without proper level of functional, technical, tactical, and psychological conditioning of athletes specializing in different sports. According to some experts, the main limiting factor to achieving high sports results, especially at the international arena, is the level of the athletes' functional preparedness (Aranson & Portugalov, 2011; Aoki, Arruda, Freitas, Miloski, Marcelino, Drago, Drago & Moreir, 2017; Horta, Bara Filho, Coimbra, Miranda & Werneck, 2017a; Doeven, Brink & Kosse, 2018).

The analysis of the scientific studies shows that failure to store the optimal level of functional preparedness over a long period of time is one of the main reasons for unsatisfaction indices of our athletes, particularly in women's volleyball (Lysenko, 2012; Kovalchuk, Shvets, Bohuslavska, Hlukhov, Pityn & Hnatchuk, 2019; Lakhdar & Zerf, 2019).

Since the last 10-15 years Ukrainian athletes have not achieved high results at the World Championships, European Championships, and Olympic Games (Pityn, Bohuslavska, Khimenes, Neroda & Edieliev, 2019). In connection with this, the most perspective way of improving the athletes' training process, and optimization of their functional preparedness in different periods of the annual cycle of sports training is, the development and practical implementation of new recovery programs. Those programs must appropriate to modern requirements, of top athletes' training process (Freitas, Nakamura, Miloski, Samulski & Bara-Filho, 2018).

2014; Pion, Fransén, Deprez, Segers, Vaeyens, Philippaerts & Lenoir, 2015; Ion-Silviu, Sorin, Paul, Tiberiu & Eugen, 2016; Sulyma, Bohuslavskaya, Furman, Galan, Doroshenko & Pityn, 2017; Hnatchuk, Lynets, Khimenes & Pityn, 2018).

The sources on the problem indicate that the question of optimizing the athletes' functional preparedness in various sports is investigated thoroughly (Vanyuk, 2013; Mielgo-Ayuso, Zourdos & Calleja-González, 2015; Kitamura, Pereira, Kobal, Abad, Finotti & Nakamura, 2017).

However, the same sources confirmed that using traditional recovery means, particularly in women's volleyball, can not fully ensure preservation of the long term optimal level of athletes' functional readiness. This is due to the focusing on increasing only certain components of the athletes' fitness. It is important that the improvement of the system of recovering measures is especially relevant during the competitive period of the annual cycle of the athletes training, because of the largest physical and psychological loads (Mielgo-Ayuso, Zourdos & Urdampilleta, 2017; Miroshnichenko, Salnykova, Bohuslavskaya, Pityn, Furman, Yakovliv & Semeryak, 2019).

The current level of the problem of improving the athletes' functional fitness in the annual cycle of sports training has indicated the following content of scientific and methodological literature. It is mainly devoted to the definition of functional fitness as the main criterion of general preparedness, discusses the features of improving the athletes' functional fitness using various recovery measures, and also demonstrated the characteristics and substantiated physiological role of antioxidant systems of the organism (Rodríguez-Marroyo, Medina Carrillo, García-López, Morante, Villa & Foster, 2016; Nuccio, Barnes & Carter, 2017)..

A separate block presents a study of the effectiveness of professional volleyball players' training, but the vast majority of studies related to the training of men in volleyball (Horta, Bara Filho, Miranda, Coimbra & Werneck, 2017b; Hnatchuk et al., 2018).

Thus, the development, experimental testing, and practical implementation into the training process of female volleyball athletes, the author's program of recovery activities is actually. It must take into account: the specific features of this kind of sports games, the period of the annual cycle of training, the nature of the correlation dependence of the athletes' functional readiness level and their physical fitness, and improves the efficiency of the training process.

The purpose of the study is to optimize the functional preparedness of female volleyball players aged 18-22 during the competitive period in the annual training cycle using antioxidant recovery measures.

Materials and methods.

Methods: analysis and generalization of scientific and methodological sources; pedagogical observations; pedagogical experiment; testing of physical performance, aerobic capabilities, functional preparedness; functional methods of investigation cardiovascular and antioxidant (nitric oxide synthesis system) systems; methods of mathematical statistics.

The level of the female athletes' physical capacity and aerobic capabilities was evaluated using a PWC₁₇₀ submaximal cycle ergometer test.

The determination of the volleyball players' functional readiness level and its individual components was carried out using the computer program "SHVSM".

The evaluation of cardiovascular functional conditions was performed with use of the variation and amplitude heart rate monitor methods and functional conditions of the antioxidant system (system of nitric oxide synthesis) – with use of the plethysmography method and tests with reactive hyperemia of brachial artery. The results of the study were processed with the standard methods of mathematical statistics.

The research was conducted on the volleyball club "Orbita-University" basis of (Zaporizhzhya City, the National league of the Ukrainian Volleyball Championship). In the terms of fixing experiment, which was attended by 36 volleyball players aged 18-22, there were studied the peculiarities of the physical capacity, functional preparedness, cardiovascular antioxidant systems functional conditions and volleyball players during the competitive period in the annual training cycle. We have designed the program of recovery measures, that taking into account the nature of athletes' fitness changes and nature of the relationship of their functional preparedness and individual components of fitness.

The forming experiment was performed in order to test our recovery measures program effectiveness during the volleyball players' competitive period and some practical recommendations were given. The forming experiment enlisted 30 volleyball players who were divided by the control (16 girls) and experimental (14 girls) groups. The program of recovery measures during the competitive period of annual training cycle for the control group included such recovery activities as a sauna, conditioning swimming, massage and self-massage, and psycho-correction means. As for the volleyball players of the experimental group, in addition to these activities, the plant adaptogen ecdysterone, which is one of the leading stimulants of the body's antioxidant system, was used.

The basic principles of the authors' program of recovery measures are the following:

- the appropriateness of the age-specific features and current fitness level of female athletes aged 18-22 included in the program of recovery measures;

- taking in the account the peculiarities of sports activity of girls aged 18-22 on the basis of the common physiological characteristics of volleyball as one of the situational sports;
- the physiological orientation of the used recovery measures is their dominant effect on the physiological systems of the body, which most provide the optimal level of functional preparedness (cardiovascular and antioxidant system (system of nitric oxide synthesis);
- the availability of the used recovery measures and the simplicity of their practical implementation;
- systematic use of all components of the comprehensive program of recovery activities;
- operational, current and step-by-step medical and biological control directed to monitoring the effectiveness of the proposed recovery measures program.

The experimental program of recovery activities during the competitive period for volleyball players aged 18-22 in the experimental group included the following components:

- *Sauna*. Used once a week at the end of each training microcycle. The duration of the procedure was 1.5-2 hours.

- *Conditioning swimming*. Conditioning swimming activity (once every 2 weeks) was included in the program of recovery measures as a means of active recreation. Duration of the lesson - 45-60 minutes. The purpose of these workouts was to maintain the level of functional preparedness of female athletes and the current level of functioning of their cardiovascular and respiratory systems. In the training process prevailed loads of aerobic nature (75% of its total volume), 25% were taken by the mixed aerobic-anaerobic exercises. Monitoring the loads was carried out according to the magnitude of heart rate - 120-140 beats \cdot min⁻¹ for the loads of aerobic nature and 140-150 beats \cdot min⁻¹ - for the aerobic-anaerobic exercises. Total metric area for 1 workout with the loads of aerobic nature was 350m, and with the loads of aerobic-anaerobic nature - 125 m.

- *Massage and self-massage*. The massage was performed by a doctor and a team's massage therapist. We used the following methods: stroking, rubbing, tingling superficial muscles of the body in combination with light calming movements. Self-massage of arms and legs was carried out by athletes independently with the help of brushes made of synthetic pile. The duration was 7-10 minutes daily.

- *Psycho-correction*. In our study, the program of psycho-correction included: auto-suggestion using the self-management techniques by G. M. Pokalov and autogenous training by I. M. Schulz. The following volume of training was offered: duration - 30-40 minutes, frequency - once every 2 weeks. Further - one supporting training per month. Psycho-correction trainings were conducted by a group of specialists of the Faculty of Social Pedagogy and Psychology of Zaporizhzhya National University.

- *Use of antioxidant drugs (adaptogen ecdysterone)*. In order to prevent the decrease of physical capacity, the level of functional preparedness, the worsening of the functional conditions and the adaptive ability of the volleyball players' bodies during the competitive period, we offered the use of antioxidant agents - plant adaptogen ecdysterone as a part of the program of recovery measures. We did it for increase the activity of antioxidant systems of their organisms.

Making the experiment, during the competitive period in an annual training cycle, volleyball players aged 18 - 22 were given ecdysterone in the form of herbal syrup for the whole competition period (8 months, 30 games) from October to May. It was carried out according to the designed scheme based on the common data about the volume, cyclicality and the duration of substance using (official data taken from instructions on ecdysterone). Also with proposals and recommendations of the team doctor and experts from Institute of Physiology named after O. O. Bohomolets and Institute of Biochemistry named after O. V. Palladin, affiliated to Academy of Sciences of Ukraine.

According to the developed scheme, the administration of ecdysterone to volleyball players aged 18-22 in the experimental group was as follows: 10 days of admission monthly during the competition period of the annual training cycle alternated with a 15 day break.

The daily intake ranged from 37.5 milligrams (75 % of the maximum daily dose) to 50 milligrams (maximum daily dose).

At the first and last 3 days of each cycle, the daily dose of ecdysterone was 37.5 mg or 75% of the maximum daily dose, on the 4th, 5th and 7th days of each cycle volleyball players took 45 mg of ecdysterone (90% of the maximum daily dose). The peak of taking ecdysterone (50 milligrams a day) was on the 6th day of each cycle.

Results.

At the beginning of the competitive period, the volleyball players had the above average levels of their overall physical capacity, aerobic capabilities, functional preparedness, as well as the optimal level of the cardiovascular and antioxidant systems functioning.

It is indicated as well, that at the end of the competitive period, the tested athletes showed obvious ($p < 0.05$) worsening of their general fitness: decline of physical capacity and aerobic performance (respectively 38.38% and 27.8%), general, speed and speed-power endurance (by 48.79%; 42.92%; 58.09%), the cardiac efficiency index and adaptive potential (by 28.22% and 42.12%), the functional conditions of the antioxidant system (by 67.19%) and general level of functional preparedness (by 52.98%).

Moreover, we observed the increase by 34.94% in the degree of functional tension on the circulatory system regulatory mechanisms of the examined volleyball players aged 18-22 (Fig. 1).

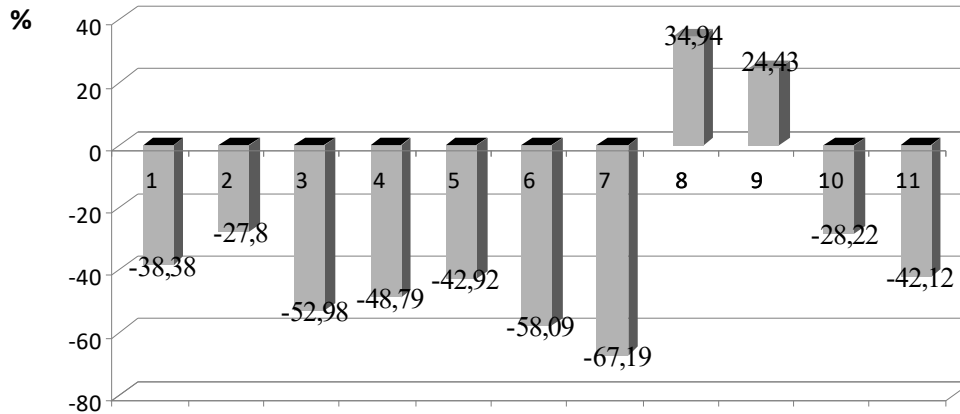


Fig. 1. Changes in indices of physical capacity, functional preparedness, functional conditions of the circulatory system and the antioxidant system of volleyball players aged 18-22 after the fixing experiment (in % of initial values).

Notes: 1 - PWC_{170} ; 2 - MOC (maximum oxygen consumption); 3 - the level of functional preparedness (LFP); 4 - general endurance (GE); 5 - speed endurance (SE); 6 - speed-power endurance (SPE); 7 - increase in diameter of the brachial artery (DBA); 8 - tension index of the circulatory system (Icst); 9 - index of vegetative equilibrium (Ive); 10 - index of the heart efficiency (Ihe); 11 - adaptive potential of the cardiovascular system (APcs).

In our opinion, one of the main reasons for the significant worsening of the volleyball players' general fitness at the end of the competitive period was a decrease in the functional conditions of their bodies' antioxidant system (nitric oxide synthesis system).

The results of the fixing experiment confirmed a significant decrease in the level of functional preparedness of volleyball players aged 18-22 during the competitive period, negative changes in the cardiovascular and antioxidant systems functional conditions of their organism and the need to improve the system of recovery measures for athletes.

With the purpose of experimental evaluation of the developed recovery measures program effectiveness we examined the features of the fitness dynamics of both volleyball players' groups during the competition period of annual training cycle.

Conducted at the beginning of the forming experiment, testing of volleyball players aged 18-22 allowed to establish the relative homogeneity of athletes in the control and experimental groups and absence of significant ($p > 0.05$) intergroup differences as for all studied parameters.

The results of the forming experiment indicate that at the end of the competitive period volleyball players, who followed the offered recovery activities, didn't show statistically significant changes ($p > 0.05$) by most parameters of their general fitness, and their natural decrease was only 5-8% (Table 1).

Table 1

Indices of physical capacity, functional preparedness, functional condition of antioxidant and cardiovascular systems volleyball players in the experimental group at the beginning and at the end of experiment ($\bar{X} \pm S$)

Indices	Beginning	Completion	% change
PWC_{170} , $kgm \cdot min^{-1} \cdot kg^{-1}$	20.46 ± 0.69	19.08 ± 0.65	-6.72 ± 1.37
MOC , $ml \cdot min^{-1} \cdot kg^{-1}$	59.77 ± 1.53	56.71 ± 1.45	-5.12 ± 1.38
GE, points	75.91 ± 2.97	70.4 ± 2.76	-7.27 ± 1.36
SE, points	69.26 ± 3.00	65.43 ± 2.83	-5.53 ± 1.38
SPE, points	66.41 ± 2.48	61.79 ± 2.31	-6.95 ± 1.37
RFL, points	72.67 ± 3.02	68.37 ± 2.84	-5.92 ± 1.37
Icst, conv. units	124.55 ± 4.81	$158.52 \pm 9.18^{**}$	27.27 ± 2.15
Ive, conv. units	164.59 ± 9.18	$204.58 \pm 11.14^{*}$	24.30 ± 1.57
Ihe, conv. units	118.52 ± 4.17	109.22 ± 2.84	-7.85 ± 1.21
APcs, conv. units	0.78 ± 0.11	0.67 ± 0.09	-14.63 ± 1.29
DBA %	30.92 ± 5.17	23.15 ± 4.22	-25.55 ± 1.29

Note: * - $p < 0.05$; ** - $p < 0.01$ compared to the values recorded at the beginning of the experiment.

The obvious was only raising the level of functional tension of circulatory system regulatory mechanisms of the volleyball players in the experimental group (to 27.27%) due to increasing signs of the athletes' natural fatigue at the end of the season.

A convincing confirmation the high effectiveness degree of our antioxidant recovery program is the results of the data comparative analysis of the volleyball players' final testing at the control and experimental groups (Table 2).

Table 2

Indices of physical capacity, functional preparedness, functional conditions of antioxidant and cardiovascular systems of the volleyball players of the control and experimental groups after the formative experiment ($\bar{X} \pm S$)

Indices	Control group	Experimental group	% changes
PWC ₁₇₀ , kgm/min ⁻¹ •kg ⁻¹	16.43 ± 0.56	19.08 ± 0.65 **	16.12 ± 1.53
MOC, ml/min ⁻¹ •kg ⁻¹	49.31 ± 1.26	56.71 ± 1.45 ***	15.00 ± 1.52
GE, points	56.76 ± 2.22	70.40 ± 2.76 ***	24.01 ± 1.59
SE, points	57.68 ± 2.50	65.43 ± 2.83 *	13.43 ± 1.51
SPE, points	53.94 ± 2.02	61.79 ± 2.31 **	14.57 ± 1.52
RFL, points	55.09 ± 2.29	68.37 ± 2.84 ***	24.11 ± 1.59
Icvs, conv. units	247.94 ± 12.65	158.52 ± 9.18 ***	-36.07 ± 1.24
Ive, conv. units	287.33 ± 14.75	204.58 ± 11.14 ***	-28.80 ± 1.25
Ihe, conv. units	65.28 ± 2.83	109.22 ± 2.84 ***	67.31 ± 1.42
APcvs, conv. units	0.31 ± 0.07	0.67 ± 0.09 **	116.13 ± 1.63
DBA, %	11.71 ± 2.64	23.15 ± 4.22 *	97.69 ± 1.89

Note: * - $p < 0.05$; * - $p < 0.01$; ** - $p < 0.01$; *** - $p < 0.001$ compared with the values of the athletes in the control group.

It was recorded that after the formative experiment, the volleyball players in the experimental group showed significantly ($p < 0.05$) higher than the athletes in the control group, values of the general physical capacity, aerobic performance, the level of functional readiness and more optimal level of the cardiovascular and antioxidant systems functional state.

The results of the formative experiment indicate that the implementation of the experimental program of antioxidant recovery measures during the competition period of volleyball players aged 18-22 helps to optimize significantly the functional preparedness of athletes and increase the efficiency of the training process. This gives reason to recommend this program for practical use in the system of sports training of volleyball players aged 18-22 at the stage of preservation their high sportsmanship.

Discussion.

The conducted research indicates that the introduction of volleyball players in the training process according to the new programs of recovery measures, in particular those that have a clear antioxidant nature, can for a long time ensure the optimal level of female athletes' functional readiness. According to most experts, maintaining a high level of functional preparedness during the competition period of the annual training cycle is of great importance, since at this stage the most significant adverse effect of significant physical and psychological load on the athletes' bodies (Freitas et al. 2014; Hnatchuk et al., 2018; Horta et al., 2017b).

Thus, the development of new recovery measures programs for volleyball players during the competition period in the annual training cycle, aimed at optimizing the level of their functional preparedness and efficiency of the training process, makes the research relevant (Azboy & Kaygisiz, 2009; Doeven et al., 2018).

The study realized a theoretical generalization and proposed a new solution to the scientific problem, which consists in the development of an experimental program of antioxidant recovery for volleyball players aged 18-22 during the competition period in the annual training cycle in order to optimize the level of their functional preparedness and increasing the effectiveness of the training process.

Effective solution of the problem of maintaining at the optimum level the athletes' functional preparedness within the annual cycle of sports training is possible only with the development of new recovery measures programs, taking into account the latest achievements in sports science.

The materials obtained during the fixing experiment made it possible to state that using traditional recovery measures program among the volleyball players aged 18-22 during the competition period does not contribute to maintaining at the optimal level their functional readiness and other components of physical fitness:

- at the end of the fixing experiment, there was a significant ($p < 0.05$) decrease in the level of the athletes' physical performance (by 38.38 ± 1.43%), aerobic performance (by 27.80 ± 1.55%), alactate and lactate values capacity (35.23 ± 1.73% and 42.54 ± 1.79%, respectively), alactate and lactate volume (34.24 ± 1.73% and 42.18 ± 1.79%), anaerobic threshold metabolism, heart rate at the level of PANO (respectively by 16.52 ± 2.10% and 26.18 ± 1.51%), total metabolic capacity (by 27.60 ± 1.56%), economy of the energy supply system

of muscular activity and backup capabilities ($59.42 \pm 1.37\%$ and 60.16 respectively) 1.66%), the levels of speed, power and general endurance ($42.92 \pm 2.41\%$, $58.09 \pm 2.13\%$ and $48.79 \pm 2.19\%$ respectively), as well as the female athletes' general level of functional preparedness (by $52.98 \pm 1.83\%$);

- before the completion of the fixing experiment the female athletes showed a significant ($p < 0.05$) decrease in stroke blood volume by $17.42 \pm 3.17\%$, minute blood volume by $16.19 \pm 2.07\%$, negative significant increase in total peripheral vascular resistance (by $45.93 \pm 10.62\%$), I_{est} values (by $34.94 \pm 1.38\%$), I_{ve} (by $24.43 \pm 1.28\%$), as well as a significant decrease in values I_{he} (by $28.22 \pm 1.17\%$), AP_{cs} (by $42.12 \pm 1.10\%$) and increase in diameter of the brachial artery after the test with reactive hyperemia (by $67.19 \pm 1.34\%$);

- throughout the entire fixing experiment, the strongest positive correlation between the level of functional preparedness of volleyball players was observed with the indices characterizing the state of their body's antioxidant system.

To optimize the level of functional readiness and other components of the volleyball players' aged 18-22 fitness during the competition period in the annual training cycle, a program of antioxidant recovery measures was developed, which takes into account the peculiarities of the correlation dependence of the level of female athletes' functional preparedness with their general fitness.

The hallmarks of this program are the use of the plant adaptogen ecdysterone, which has a clear antioxidant and ergogenic nature. The form, the effective scheme and the dosage of the use of ecdysterone during the competition period are proposed, depending on the duration of the competition period, the calendar of competitions and the current level of the female athletes' fitness. Ecdysterone is taken as a phytosyrup, alternating every 10 days with a 15 - day break, the maximum daily dose is 50 mg, in the first and last 3 days of each cycle. The daily dose of ecdysterone is 75% of the maximum daily dose, on the 4th, 5th and on the 7th day of each cycle - 90% of the maximum daily dose, and the peak of taking ecdysterone falls on the 6th day of each cycle.

Thus the important role of application of athletes' training process rationally designed system of recovery measures that have a physiological focus and take into account the characteristics of their sports activity was confirmed (Debien et al., 2018; Doroshenko et al., 2019).

Besides, there were supplemented the experimental results of physiological changes in the body of volleyball players aged 18-22 during the competitive period in annual training cycle under the influence of complex recovery measures. These changes manifested in reduction of functional tension level of cardiovascular system regulatory mechanisms and optimize the nitric oxide synthesis functional condition (Lysenko, 2012; Sulyma et al., 2017; Lakhdar & Zerf, 2019).

Materials of the performed study added to the data on the dynamics of functional preparedness of the athletes, who specialize in volleyball, during the competition period in an annual training cycle at the stage of preservation of high sportsmanship (Mielgo-Ayuso, Zourdos & Urdampilleta, 2017; Doeven, 2018).

We first developed the program of recovery measures of antioxidant nature for the volleyball players aged 18-22 during the competition period, which considered the correlation of players' functional preparedness level and their nitric oxide synthesis functional condition level, could be recognized as a modern one.

The formative experiment proved that the application of the antioxidant recovery measures program during the competitive period of the volleyball players aged 18-22 helped optimize the level of the athletes' functional preparedness and increase the efficiency of the training process at the stage of maintaining high sportsmanship.

Conclusions

1. The use of the author's program of recovery activities designed for the volleyball players during the competition period in the annual training cycle contributed to the substantial optimization of functional preparedness and other components of fitness of the examined female athletes:

- after the formative experiment the volleyball players aged 18-22 of experimental group didn't show any significant changes in their levels of physical capacity, aerobic performance, alactate and lactate capacity and volume, anaerobic metabolism threshold, heart rate at PANO, efficiency system of muscular activity energy supply, reserve capacities, as well as levels of general, speed, and power endurance, and general level of functional preparedness. The decrease in all indices was only 5-8%;

- at the end of the competition period, there were no significant ($p > 0.05$) changes in the functional conditions of the central hemodynamics and antioxidant system of the athletes in the experimental group on the background of the natural, slight increase in the degree of an organism's regulatory systems functional tension and decrease in the adaptive capacity of the circulatory system;

- after the formative experiment the volleyball players in the experimental group experienced significantly higher, in comparison with the control group athletes, values of physical performance, aerobic performance, alactate and lactate capacity and volume, anaerobic metabolism threshold, heart rate at PANO, general metabolic capacity, efficiency system of muscular activity energy supply, reserve capacities, levels of general, speed, and power endurance, functional readiness, heart rate efficiency, adaptation capacity of the cardiovascular system, increase in the brachial artery diameter, linear and volumetric blood flow velocity and

lower values of the total peripheral vascular resistance, tension index of regulatory mechanisms of the circulatory system and index of vegetative balance.

2. Obtained during the formative experiment results indicate that the application of the authors' program of antioxidant recovery measures designed for the volleyball players aged 18-22 during the competition period in an annual training cycle helped optimize the athletes' functional preparedness and other components of their fitness and efficiency of the training process.

Competing Interests

The authors declare that they have no competing interests.

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