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ABSTRACT

IMPACT OF WRESTLING EXERCISES ON BLOOD LIPID SPECTRUM AND SEVERAL IMMUNE INDICATORS

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The dissertation research was conducted in the laboratory of "Radiation physiology" of the Institute of Physiology named after academician Abdulla Garayev under the Ministry of Science and Education of the Republic of Azerbaijan and within the Departments of "Medical and biological sciences" and "Combat sports" at the Azerbaijan Sports Academy.

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GENERAL CHARACTERISTICS OF THE STUDY

Actuality and problem of the study. One of the carriers of the historical and cultural memory of our national mentality, wrestling, which is included in the list of modern Olympic sports, makes such important demands as high competitiveness, increasing training loads for specialists, increasing physical performance, accelerating recovery processes and protecting one's health[1].

The types of wrestling were distinguished for their popularity in our country and have always been in the spotlight. Recently, new rules applied to Olympic competitions have made the competition in this sport more dynamic, intense and organized[2,3]. A constant increase in the volume and intensity of training loads has a positive effect and is essential in achieving the expected results. At the same time, the intensification of training and competitive loads is accompanied by some negative consequences for the body, causing certain deficits in the activity of the athlete's immune system. Thus, limiting and over limiting training loads cause very sharp, sometimes irreversible changes in the morphological, physiological and biochemical parameters of the body. Weakening of the immune system accelerates the development of diseases. Obtaining and applying complete information about the morpho functional and biochemical changes occurring in their body in the process of training and improving high-class wrestlers provides ample opportunities to increase the effectiveness of training, and a correct assessment of the dynamics of indicators of adaptation to the loads used in the training process not only increases efficiency physical training, but also keeps the health

[1] Alibekova S.S. The study of the state of the immune system of athletes during physical exertion. News of ANAS (biological and medical sciences), volume 72, No.2, pp. 159-166.

[2] Sternin Yu.I. Features of the regulation of the immune system under high physical activity / Yu.I. Sternin, L.P. Syzyakina, G.Yu. Knorring / / Cytokines and inflammation. – 2007 a. - v.2. - pp.31 -34.

[3] Sternin Yu.I. Several immunological indicators during sport activities / Yu.I. Sternin, L.P. Syzyakina / / Terra-Medika. – 2007, – v.6. - pp.342-51.

of the athlete under control[4]. The analysis of literature sources of recent periods indicate that scientific studies conducted on wrestlers mainly covered the methodological and pedagogical aspects of the organization of exercises; insufficient attention was paid to the state of morphophysiological and biochemical parameters in the athlete's body. Changes in the morphological, physiological and biochemical parameters of physical activity, which effectively affect the improvement of the sportsmanship of wrestlers, and their effect on the immune status have not been studied enough. To determine the individualization and differentiation of changes caused by metabolic processes activated in the body of a wrestler under the influence of training loads, the registration of their somatotypes, the study in conjunction with the immune system and their physiological justification remain an urgent issue in the physiology of sports training[5,6]. The above-mentioned issues make it relevant to study the level of development of adaptation of wrestlers to training loads and the changes in the immune status caused by them and form the basis for the effectiveness of sports training. Based on the above-mentioned, the study of changes in morphological, physiological and biochemical parameters of the body in freestyle wrestlers caused by training loads and the determination of their relationship with the immune system increases the relevance of our study.

The objective and tasks of the study. Our main objective in the dissertation study was to determine the morphological, physiological, biochemical and immunological parameters of the body against the background of physical loads at different stages of the training process in wrestlers of different levels and to assess individual preparedness against the background of physical loads.

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[4] Merinova N.I. Lipid peroxidation and antioxidant system in the pathogenesis of chronic pancreatitis / N.I. Merinova, N.I. Kozlova, L.S. Kolesnichenko // Siberian medical journal - Irkutsk, 2012 - v.110 - No.3 - pp.17- 20.

[5] Suzdalnitsky R.S. New approaches to the understanding of sports stress immunodeficiencies / R.S. Suzdalnitsky, V.A. Levenda / Theory and practice of physical education. - 2003. - v.1. – p.18.

[6] Dorovskich V.A. Antioxidant drugs of various chemical groups in the regulation of stressful effects /V.A. Dorovskich, S.S. Tseluyko // Far eastern medical journal – Khabarovsk, 2004 .– p.268.

In accordance with the relevance and purpose of the research work, the following tasks were performed:

1. Assessment of the dynamics of the morpho functional state of wrestlers in different periods of the training and competitive process (preparatory, pre-competitive and competitive periods);

2. Influence of the orientation of physical loads used in different periods of the training and competitive process on the lipid spectrum of the blood of freestyle wrestlers and assessment of their level of physical fitness;

3. The study of indicators of immune system of wrestlers during various periods of training and competitions (the number of leukocytes and lymphocytes in the blood, the concentration of immunoglobulins A, M, G and C-reactive protein in the blood serum);

4. Evaluation of the total oxidant and antioxidant capacity of the blood of athletes in the corresponding periods of the training and competitive process.

The main provisions that were submitted for defense:

1. It has been established that an increase in lipid metabolism in the process of long-term adaptation to intense physical activity is characterized by a higher efficiency of triglycerides and low-density lipoproteins as an energy source in 1st class wrestlers and candidates for sportsmanship and a lower value as an energy substrate in masters of sports and international class athletes.

2. It was determined that a number of indicators of the response of humoral and cellular immunity to physical activity can be used to assess the intensity and duration of the training load.

3. It has been established that the concentration of IgG, IgA, IgM in the blood serum of freestyle wrestlers corresponds to their model indicators of the applied training loads.

4. Since the performance of large-scale and intense loads by professional wrestlers creates conditions for the development of allergic diseases in them, they constitute a risk group.

5. Cytokines, which serve as the main indicators of rapid adaptation to physical activity, have an informative role in assessing long-term adaptation to physical activity.

6. It has been determined that with long-term adaptation of the body of athletes to physical activity, along with an increase in oxygen transfer, lipid metabolism also increases (the concentration of DC, MDA, H_2O_2, etc. increases).

Scientific novelty of the research. Morphological, physiological, biochemical and immunological criteria for evaluating the professionalism of athletes involved in wrestling have been determined and compared with existing model indicators. For the first time, based on the study of the relationship of physical activity with the state of the immune system, lipid profile and somatotypes, physiological and anthropological complex studies were carried out in wrestlers, depending on age and fitness level. It was determined that high-level wrestlers have certain advantages over low-level wrestlers due to body morphological parameters. These indicators can serve as criteria for selection in sports. For the first time, studies have identified the direction of lipid profile changes in non-athletes and wrestlers. The findings revealed an increase in total cholesterol (TC), triglycerides (TG), and low-density lipoprotein cholesterol (LDL), alongside a decrease in high-density lipoprotein cholesterol (HDL). It was also determined that changes in the lipid profile become less pronounced with higher levels of athletic skill. Specifically, candidates for first-grade ranks and Master of Sports wrestlers with a muscular body structure showed an increase in total cholesterol (TC), while those with asthenic and thoracic body types exhibited a decrease. A reduction in the low-density lipoprotein cholesterol (LDL) fraction was observed across all somatotypes.

Theoretical and practical significance of the research. The results of the study not only make a certain contribution to sports biochemistry and physiology, but also expand knowledge about the features of professional wrestlers' body adaptation to physical loads. An extensive analysis of the results of the study extends our opinions about the main directions of adaptive reactions depending on the fitness of the immune status indicators and the blood lipid profile of wrestlers of different levels. Identifying informative indicators that characterize the body's response to physical activity is crucial for assessing athletes' individual fitness levels. A new diagnostic approach was proposed using

immunological criteria to assess the degree of adaptation to physical activity. The obtained results can contribute to the prevention of allergic reactions caused by internal and external factors in high-class wrestlers, as well as to identifying disease predispositions by enhancing diagnostic efficiency and accuracy. Additionally, it is noteworthy that biologically active food supplements are used to mitigate lipid peroxidation (LPO) processes triggered by intense physical exertion. The findings indicate that these antioxidant supplements effectively suppress LPO and partially limit its harmful effects.

An analysis of the results suggests that theoretical knowledge of immunocorrection principles could significantly improve the organization of training exercises for athletes. These insights are also valuable for sports physicians, specialists in sports medicine and physiology, and professionals in clinical diagnostic laboratories. The findings on morphofunctional, metabolic, and immune indicators of the body's adaptation to physical activity can be effectively applied in athlete selection processes. These indicators can also guide the selection and dosing of training loads in freestyle wrestling, optimizing them on scientific and methodological bases.

Changes in the immune system can serve as early detection criteria for potential diseases. Informative results regarding the body’s response to various training loads during individual macrocycles allow for precise immunological diagnostics of individual adaptation. Using immunological methods enhances the accuracy of early diagnostics and the prevention of allergic conditions, enabling the classification of athletes into specific risk groups. Moreover, the results contribute to expanding theoretical knowledge, supporting the implementation of basic immunocorrective measures during sports training. These findings are expected to benefit specialists in sports physiology, sports biochemistry, and sports medicine, as well as trainers, general practitioners, and professionals in diagnostic laboratories.

The dissertation findings have been incorporated into lecture content for sports physiology, sports medicine, and sports biochemistry, as well as into practical sessions on sports biochemistry. Additionally, it is recommended to use these results as experimental

material to enhance physical fitness in wrestling lectures and to support medical monitoring in sports.

Approbation (approval) of dissertation. The main results of the dissertation were discussed at the following scientific conferences, symposiums and congresses:

1. The proceedings of Third National Congress of Physiological Society named after I.Beritashvili. The Republic of Georgia, Tbilisi. October 26-29, 2013;
2. Physical culture and mass sports at the essence of health-saving technologies. All-Russian scientific and practical Conference with international participation. Moscow city, June 18, 2014;
3. Physics, Chemistry and Philosophy of Olympic sports. International scientific and practical conference. Baku city, October 16-19, 2014;
4. University sports: the health and prosperity of the nation: Proceedings of the international scientific conference of students and young scientists. Kazan. State University of Physical Culture, Sports and Tourism (SUPCST), April 23-24, 2015;
5. V Congress of physicists of the CIS. Sochi-Dagomys, Russia, Special issue, October 4-8, 2016;
6. V Congress dedicated to the 50th anniversary of the Institute of Physiology named after A.I. Garayev of the Ministry of Science and Education of the Republic of Azerbaijan and Physiology Society. Baku, 2017;
7. XXIII Congress of Physiologist Society named after I.P. Pavlov. CIS. Russia, Voronezh, September 18-22, 2017;
8. Modern football: status, problems, innovations, and development prospects. All-Russian scientific and practical Conference with international participation. Kazan, Povoljsk State University of Physical Culture, Sports and Tourism, June 29-30, 2018;
9. Modern problems of the theory and practice of physical education, sports disciplines and tourism. International scientific and practical Conference. Ukraine. Pereyaslav-Khmelnitsky, November 23, 2018;

10. The role of physical culture and sports in the prosperity of the nation. I International scientific and practical Conference. Kharkov, October 3-4, 2019;

11. “Problems of modern medicine”. Scientific and practical Conference dedicated to the 90th anniversary of corresponding member of ANAS, honored scientist, professor D.V. Hajiyev. ATU, 2019;

12. “Modern problems of Biology”. International Scientific Conference dedicated to the 100th anniversary of Azerbaijan Democratic Republic. Sumgayit, October 23-24, 2018;

13. Scientific and practical conference dedicated to the results of scientific-research works in the field of physical education and sports (Azerbaijan State Academy of Physical Education and Sport (ASAPES), 2015, 2018);

14. VII International Scientific and Practical Conference. “Scientific achievements of modern society”., Liverpool, 4-6 march, 2020;

15. Eurasian Scientific Congress., Barcelona., January 27-28, 2020;

16. VII International Scientific and Practical Conference. “Topical Issues of the Development of modern science”. Sofia, Bulgaria, March 11-13, 2020;

17. Proceedings of the X International Scientific Conference of Students and Young Scientists, Omsk, 2020;

18. Modern society, education and science. International scientific and practical conference. Russia, Tambov, August 31, 2020;

19. The XXXIII International Scientific Symposium. Dialogue of Sciences and cultures in the modern World.Kyrgyzstan, Bishkek, The 24th of December, 2022;

20. International Scientific Symposium. "The great silk road: The bridge between east and west", Turkey, Kars, 2023.

Published works – 28 works were published on the subject of dissertation.

Structure and volume of dissertation study. The dissertation work is compiled on 160 (218518 characters in total) pages of computer text. It consists of the structural sections - "Table of

Contents" (1826 characters), "Introduction" (17355 characters), "The main content of the dissertation" (194023 characters), "Results" (2629 characters), "Practical recommendations" (1193 characters) and "List of references".

The section "The main content of the dissertation" is divided into 4 chapters. Chapter I: "Literature summary" (64373 characters); Chapter II: "Materials and methods of research" (24443 characters); Chapter III: "Practical-experimental part" (75099 characters); Chapter IV: "Discussion of the obtained results" (30085 characters). The study is illustrated with 19 tables and 12 diagrams. The list of references includes 160 sources, out of which 11 are in Azerbaijani, 83 in Russian and 66 in English.

Materials and methods of the study. The studies were conducted on athletes aged 18-22, engaged in freestyle wrestling, including masters of sports of international class, starting from the 1st category. The surveyed athletes were divided into 2 groups depending on the sports category, skill and experience: group 1, which included athletes from 1st category to candidates of sportsmanship (n=16) and group 2, which included athletes from masters of sports to international sportsmanship (n=12). Comprehensive examinations conducted with wrestlers included the study of general and sports anamnesis, samples of dosed physical activity, indicators of physical development (height, weight and chest circumference). Among the methods of functional diagnostics: spirometry, pulsometry, sphygmomonometry, carpal dynamometry, determination of breath holding time on inhalation and exhalation (Stange and Genche tests), PWC (Physical Work Capacity)$_{170}$, Harvard step test (HSTI), bicycle ergometric methods, calculation of VO2max (Maximum Oxygen Consumption) and biochemical methods were used. All methodological techniques were carried out in accordance with the requirements for laboratory research, in compliance with the rules of bioethics.

Determination of Physical Work Capacity (PWC_{170}) and Maximum Oxygen Consumption (MOC). PWC_{170} and OMS in wrestlers were measured by bicycle ergometric method and calculated with the assistance of relevant formulas.

Blood morphological analysis. Blood samples were taken 15-30 minutes before and after exercise. The studies were carried out at the beginning of the preparation period, before the competition and during the competition. The control group consisted of completely healthy students who were not engaged in wrestling. In immunological analyzes, the types of immunoglobulins included in the main classes, the number of types of leukocytes, the activity of lymphocytes, and cytological examination of blood serum were determined**.**

Blood biochemical analysis. Lipid spectrum indicators were determined in serum and plasma obtained from a blood sample: triglycerides, total cholesterol, high-density lipoprotein cholesterol (HDLP-CHS), low-density lipoprotein cholesterol (LDLP-CHS); the measurements were carried out on a semi-automatic biochemical analyzer using reagents from the company "Labsystems" (Finland).

Determination of products of lipid peroxidation (LPO). The intensity of lipid peroxidation was determined by the reaction of malondialdehyde (MDA) with thiobarbituric acid (TBT) (according to Asakawa), due to its concentration. And the concentration of MDA in the blood serum was determined based on the methods proposed by Andreeva et al. The value of the constant "K" is calculated by the following formula:

$$K = \frac{(DK + MDA}{KAT + SOD}$$

RESULTS OF THE STUDY AND THEIR DISCUSSION

1. Assessment of dynamics in the functional state of the wrestlers during various phases of training and competition process

The main indicators of the cardiovascular and respiratory systems were studied in order to assess the functional state of wrestlers in certain periods of annual training. At this time, it is planned to implements examinations of wrestlers in the preparatory and pre-competitive periods of the annual training. Thus, to assess the impact of specific training loads on the state of the cardiovascular and respiratory systems and the level of physical performance, the number

of pulse loads, blood pressure index, respiratory rate and lung life capacity were determined (Table 1).

Table 1

Central indicators of hemodynamics during the annual training of wrestlers of different categories (M±m)

Groups	Indicators	Indicators of hemodynamics				
		Heart Rate (HR/pulse), beat/minute	Systolic volume, ml	Minute Volume of Blood Circulation (MVB) liter/minute	Systolic pressure, mm. Barometric column	Dystolic pressure, mm. Barometric column
Control group	M±m	74.0±1.70	77.52±3.74	5.30±0.30	118.45±2.78	77.65±1.82
	%	100	100	100	100	100
1st group athletes (1st level – Candidate for master of sport (CMS))	M±m	66.0±1.02 **	80.64±3.06	5.08±0.24	106.06±1.12 **	67.34±1.04 **
	%	89	104	96	90	87
2nd group athletes (master of sport of international level (MSIL))	M±m	63.0±0.72 ***	90.67±3.70 *	5.54±0.31	110.09±3.10	70.40±2.18*
	%	85	117	105	93	91

Note: here and hereafter * - $p<0.05$ compared to the control group, ** - $p<0.01$ reliability among the athlete groups

As seen from the table, during relative rest, the heart rate of highly trained wrestlers was 12.8 beats/min less than that of the control group. This is related to their high level of training.

As physical activity increases, a decrease is observed in the number of heart beats, and an increase in systolic volume, which compensates for the minute volume of blood and prevents it from

decreasing. [7,8]. An analysis of the results obtained in groups I and II of wrestlers showed that although the decrease in heart rate was significantly different compared to the control group, this difference was not significant between groups of athletes. There were no significant changes in minute volume of blood circulation. Competing at a high level takes a lot of energy, which requires the development of the functions of the respiratory system, which is confirmed by an increase - a decrease in the density of breathing during the fight.

Table 2

Central indicators of hemodynamics in the wrestlers of various levels during annual pre-competition period (M±m)

Groups	Indicators	Indicators of hemodynamics				
		Heart Rate (HR/pulse), beat/minute	Systolic volume, ml	Minute Volume of Blood Circulation (MVB) liter/minute	Systolic pressure, mm. Barometric column	Dystolic pressure, mm. Barometric column
Control group	M±m	74.0±1.70	78.0±3.70	5.77±0.48	120.0±2.8	78.65±0.75
	%	100	100	100	100	100
1st group athletes (1st level – Candidate for master of sport (CMS))	M±m	64.6±1.08 **	85.6±3.08	5.52±0.37	115.08±1.8	70.4±1.6**
	%	87	110	96	96	90
1st group athletes (1st level – Candidate for master of sport (CMS))	M±m	61.4±0.98 ***	95.7±1.80 **	5.87±0.42	116.04±3.60	75.5±2.38
	%	83	123	102	97	96

[7] Yasko G.V. The influence of strength training on the immune status of athletes involved in bodybuilding /G.V. Yasko, V.V. Flegantova// Initial pathology and pathological physiology. – 2012. – т.7. – No.1. – pp. 238 – 250.

[8] Pershin B.B. Reaction of immune system on physical loads / B.B.Pershin, A.V.Geliyev, D.V.Tolstov//Russian journal of immunology. – 2002. – vol.7, No.1. – pp. 1 – 24.

Note: ** - p<0,01; *** - p<0,001.

Even when wrestlers demonstrate static tension, breathing stops for a few seconds. It also has great physiological importance, in this case energy is taken due to the anaerobic mechanism, if it is short-term. In high-level athletes, arbitrary breath holding is short-term, the Lingard phenomenon immediately manifests itself. During the wrestling, the need for oxygen is not fully satisfied and some oxygen debt remains. This is canceled during the recovery period after the load is performed. Based on the mentioned issues, a number of hypoxic load schemes are used to regulate breathing in the wrestling experiment. Those include Stange, Genche and Serkin tests. In exercises carried out using these load schemes, the working muscles of athletes adapt to work in anaerobic conditions, and therefore the development of fatigue in them slows down to certain extent (Tables 3, 4).

Table 3

Changes in the indicators of the cardiorespiratory system in the preparatory period of the annual training of professional wrestlers (M±m)

Indicator of functional status	Control group (n=8)	1st group athletes (1st level – Candidate for master of sport (CMS)) (n=7)	2nd group athletes (master of sport - master of sport of international level (MSIL)) (n=6)
Stange test, second	48.4±0.53	68.4±0.66*	90.4±0.44**
Genche test, second	35.0±0.55	45.01±0.060*	55.3±0.45**
Serkin test, second	37.0±0.52	48.0±0.55**	58.4±0.46**
Skibinsky index, points	33.4±0.64	45.5±0.60**	56.3±0.47**
Rufye test, conditional unit (CU)	12.0±0.65	6.4±0.55**	3.4±0.58**
Stamina constant, points	15.6±0.045	12.0±0.50*	7.7±0.038**
Vital capacity of lungs (VC), ml	4000±24.13	4700±35.16	5100±35.29
Adaptation potential (AP), conditional unit	2.18±0.14	1.85±0.15	1.71±0.16

Table 4

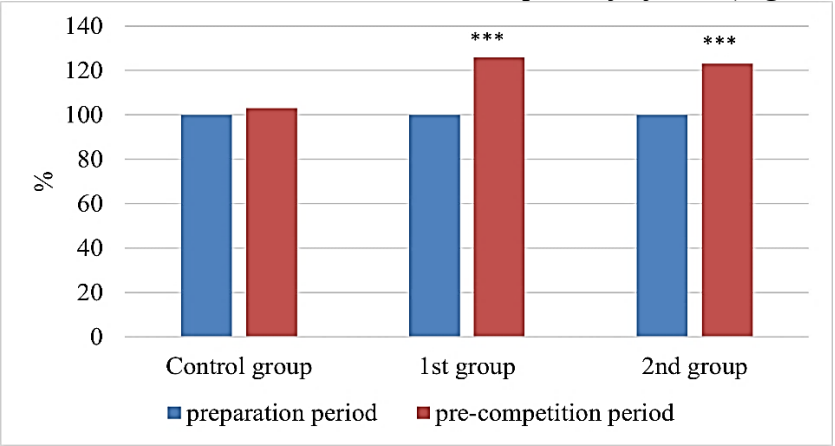
Changes in the indicators of the cardiorespiratory system in the pre-competitive period of the annual training of professional wrestlers (M±m)

Indicator of functional status	Control group (n=8)	1st group athletes (1st level – Candidate for master of sport (CMS)) (n=7)	2nd group athletes (master of sport - master of sport of international level (MSIL)) (n=6)
Stange test, second	49.5±0.54	75.4±0.64*	93.5±0.45**
Genche test, second	38.6±0.57	47.46±0.061	59.3±0.41
Serkin test, second	41.6±0.60	50.0±0.57	60.5±0.45
Skibinsky index, points	34.3±0.61	57.5±0.60*	69.4±0.46**
Rufye test, conditional unit (CU)	11.4±0.64	5.5±0.55*	2.9±0.47**
Stamina constant, points	15.2±0.45	10.3±0.60*	6.5±0.49*
Vital capacity of lungs (VC), ml	4100±31.63	4900±29.84	5400±34.63
Adaptation potential (AP), conditional unit (CU)	2.18±0.14	1.79±0.11*	1.65±0.15**

To determine the integral indicator of stamina of wrestlers with oxygen deficiency, it was assessed by Stange test from the stress samples: “bad” condition – holding the breath less than 30 seconds, “average” - 31-40 seconds, “good” - 41-60 seconds, and “excellent” condition - more than 61 seconds. Analysis of the results showed that the applied specific exercises led to a reliable increase in the duration of breathing ($p<0.05$).

Assessment in the Genche test: "bad" condition – holding the breath less than 25 seconds, "average" condition - 26-30 seconds, "good" - 31-40 seconds, "excellent" condition - breathing more than 41.0 seconds. As can be seen, with an increase in the indicators of the Genche test, as the training of wrestlers increases, an increase in the time of holding the breath after exhalation is observed. Serkin's test (breath-holding in three phases) - the duration of breath-holding after

2-3 deep breaths and exhalation after maximum breathing. The distribution of the Serkin test indicators among the examined wrestlers shows that the increase compared to the control group was 21.4 seconds and compared to 2nd group - 10.4 seconds. Thus, it was found that the wrestlers of group 2 indicated tolerance to holding their breath. We have used the Skibinsky index (SI) to characterize the functional state and stamina of the wrestlers' cardiorespiratory system (Figure 1).



Note: * - p<0.05, ** - p<0.01, *** - p<0.001 reliability of difference among the athlete groups

Figure 1. Values of Skibinsky index (SI) in wrestlers of various levels during preparation and pre-competition periods

As can be seen from the results derived, the control group SI in the preparatory period was 33.4 CU and in the precompetitive period - 34.3 CU. There were no significant changes in the functions of the cardiorespiratory system in this group.

Determination of indicators of Stamina Constant (SC) at different stages of training of professional wrestlers makes it possible to carry out sports training effectively. Normally, SC is equal to 16. As the level of training in athletes grows, the decline is observed for this figure. The indicators of SC were as follows: in the control group - in the preparatory period it was 15.6 points, in the precompetitive period - 15.2 points; In group 1 - 12.0 points in the preparatory period, 10.3 points in the precompetitive period; In group 2, it was 7.7 and 6.5 points, respectively, and was 63.0% less than in group 1.

Thus, with an increase in overall stamina in wrestlers, the work of the cardiorespiratory system improves even more, the role of aerobic energy systems increases, which characterizes the savings in the athlete's body.

The vital capacity of the lungs (VC) reflects the level of functional capabilities of external respiration, changes in its value increase adequately to performed physical loads. During the preparation period, VC in non-training participants was 4000±24.13 ml, in the pre-competitive period - 4100±31.63 ml. In a group consisting of athletes, the volume of oxygen demand increases due to the influence of training loads, but the volume of breathing remains unchanged. This suggests that the increase in VC is influenced by the lung elasticity factor.

Thus, the systematic exercises carried out in wrestling affect the respiratory rate, pulmonary ventilation, and vital capacity, increasing the functionality of the cardiorespiratory system, helping to ensure satisfying the need for oxygen at the peak of physical activity.

2. Study of changes in the blood lipid spectrum of wrestlers in different periods of the training and competitive process

It was determined that slightly higher rates were found in the cholesterol fraction of low-density lipoproteins (LDLP-CHS), and lower rates were found in the cholesterol fraction of high-density lipoproteins (HDLP-CHS). An increase in the concentration of triglycerides (TG) was noted only in the control group, and the observed differences in lipid metabolism were not statistically significant. Comparative analysis of the obtained indicators of lipid metabolism in wrestlers and the people not active in sports made it possible to identify a number of significant differences (Figure 2).

The overall level of cholesterol, besides serving as one of the most informative indicators of lipid metabolism change, is 3.99±0.11 mmol/l ($p<0.05$) in group 1, consisting of athletes (1st level - CMS), and is characterized by a low-average value. This figure was 4.39±0.10 mmol/l in those who did not train in sports. In 1st group wrestlers, the total concentration of cholesterol occurs mainly due to a decrease in the fraction consisting of LDLP. A distinctive feature of this group of athletes was the minimal use of triglycerides (TC) as the main energy substrate in accordance with the level of sportsmanship.

Comparative analysis of HDLP CHS fraction in the blood serum of athletes in 1st and 2nd groups showed that it is not statistically significant compared to the control group. Thus, as a specific response to regular physical activity used by wrestlers, lipid metabolism is involved in the overall metabolism to meet energetic and plastic needs[9,10]. Significant differences found compared to the non-training group can be assessed as an increase in the need for lipids to supply the body with energy substrates.

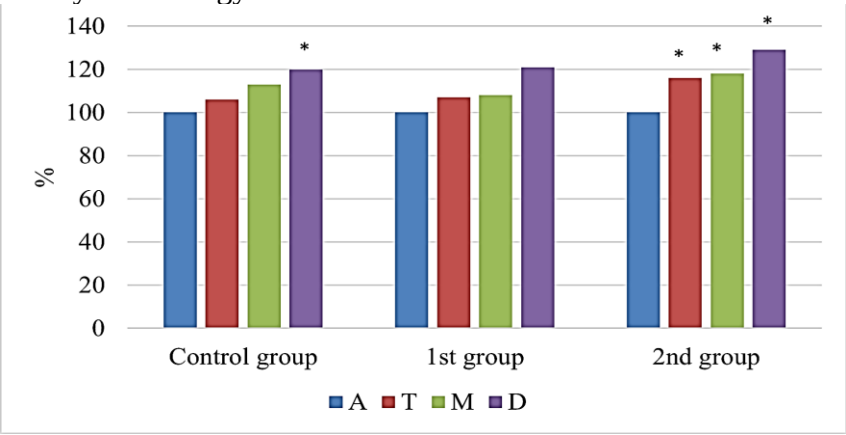


Figure 2. Total cholesterol (TC) levels in blood serum by somatotype among wrestlers of varying skill levels and non-athletes. * - $p < 0.05$ indicates statistical significance compared to Group A.

In the analysis of total cholesterol (TC) levels across control and athlete groups, the highest values were recorded for individuals with a digestive somatotype. TC levels were measured at 4.83±0.25 mmol/L in the control group, 4.42±0.28 mmol/L in the 1st group, and 4.73±0.38 mmol/L in the 2nd group. Conversely, the lowest TC levels were observed in individuals with an asthenoid somatotype, with measurements of 4.03±0.17 mmol/L in the control group, 3.66±0.22

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mmol/L in the 1st group, and 3.68±0.19 mmol/L in the 2nd group. These findings align with the consensus among researchers that individuals with higher fat composition in their body structure generally exhibit elevated TC concentrations[11]. In comparative analyses of lipid metabolism indices by somatotype, similar patterns were identified across all wrestler groups, irrespective of body type. Notably, statistically significant differences in unbound bilirubin (UB) levels were more pronounced in athletes with a muscular somatotype in the 1st group (Fig. 2). The evaluation of lipidogram indices and their comparative analysis provide a dual insight: they reveal statistical distinctions between athletes and non-athletes and highlight the specific responses of lipid metabolism to training loads in wrestlers with different body structures. This underscores the role of physiological system mobilization and activation in facilitating adaptation to training demands. The observed decrease in blood lipid spectrum during preparatory training phases in wrestlers likely reflects increased activity of lipoprotein lipase and triglyceride lipase during muscle exertion. This enhances the utilization of fatty acids as energy substrates, contributing to the body's adaptive response to the intensified physical workload.

Thus, the observed changes in the blood lipid spectrum among wrestlers indicated a trend toward a reduction in total cholesterol (TC), triglycerides (TG), and low-density lipoprotein cholesterol (LDL-C) levels compared to non-athletes. As athletic skill increases, these changes in lipid metabolism become less pronounced. Specifically, it was noted that the TC levels in wrestlers with a muscular build, particularly those at the 1st degree level and candidates for athletic skill, showed a significant decrease.

3. The study of the characteristics of the immune status indicators before and after training in different periods of training in wrestlers of different categories

Considering the important role of the immune system in protecting the mechanisms of homeostasis, the study of the immune status of athletes remains a topical issue in sports practice. The immune system is a process aimed at neutralizing the body based on its reaction to foreign

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agents penetrating into organism. The study of different types of immunoglobulins at different stages of physical activity helps them control the immune status of the body. An analysis of the results obtained during the examination of immunoglobulins in non-training people and wrestlers of various categories demonstrates that their number was significantly increased compared to the control group (Table 5).

Table 5

Dynamics of immunological indicators of high-level wrestlers during training preparation and competition periods (M ±m)

Indicators	Control group, n=5	1st group (Level 1 - CMS)		2nd group (MS - MSIL)	
		Preparation period, n=5	Competition period, n=5	Preparation period, n=5	Competition period, n=5
Ig G, q/l	13.60±2.1	14.80±2.4	15.77± 2.6*	12.75± 2.8*	13.50± 3.0*
Ig A, q/l	2.53±0.70	3.30±0.6	3.64± 0.68	2.06± 0.61*	2.13± 0.13**
Ig M, q/l	1.09±0.54	1.26±0.5	1.51±0.51	0.96± 0.67*	2.80± 0.64**
Ig E, ME/ml	201.00±6.4	301.95± 6.9	443.90± 6.00**	40.28±7.1	72.97± 8.0**
Component of C_3 complex, g/l	0.62±0.11	1.28± 0.13*	1.69± 0.10**	1.04± 0.18*	1.84± 0.16**
Component of C_4 complex, g/l	0.22±0.08	0.26±0.07	0.30±0.04	0.27±0.13	0.33±0.14

Note – here and in further tables: * - $p<0.05$ reliability compared to control group; ** - $p<0.001$ reliability of difference between the groups

As we may see from the comparative analysis of the results, there is a tangible increase in the amount of immunoglobulins in both wrestlers of groups 1 and 2 ($p<0.05$). Comparison of groups consisting of wrestlers of low and high level showed that a significant change occurred in group 2, relative to both the period of preparation of group 1 and the competitive period.

The concentration of Ig M increased in the studied groups both in the training and in the competitive period among the high-level wrestlers compared to those in the control group ($p<0.05$).

It should be noted that the results for concentration of IgE in blood serum for high-level athletes of group 2 was significantly decreased compared to the athletes of control group and athletes of group 1 ($p<0.01$). However, the increase in group 1 was higher than in athletes of both the control group and group 2 ($p<0.001$).

Thus, the change in the main classes of immunoglobulins (IgG and IgM) under the effect of training loads used in high-level wrestlers is consistent with the available literature sources[12]. The decrease in the concentration of these classes of immunoglobulins is probably associated with their enzyme system. In contrast to the performance of moderate-intensity physical activity in wrestlers, during long-term and intensive training, significant changes in the parameters of the phagocytic, T- and B-cell immunity circuits occur. This leads to the emergence of secondary immunodeficiency, which limits the physical working capacity of athletes[13].

Disturbance of the immune status when performing high-intensity training loads causes overstrain of the body, which, in turn, can lead to a weakening of its resistance to internal and external environmental factors. It is known that risk of emergence of infections grow during such changes[14]. It is considered that stress hormones, especially high levels of cortisol, are the main factor responsible for the decline in the immune cell population that is characteristic of post-exercise exhaustion syndrome[15].

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[13] Donnikov A.E. The use of some markers of urgent adaptation of the immune system to assess exercise tolerance (methodological recommendations) / A, E, Donnikov, V. A. Shleptsova. - M.: All-Russian Scientific-Research Institute of Physical Culture and Sports (VNIIFK), 2009. B - 14 p.

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One of the consequences of the weakening of T-cell immunity is believed to be the activation of the B-system, which is observed during the development of autoimmunity. However, there is an opinion that single and repeated physical activity does not change the overall level of immunoglobulins, including IgG. The main purpose of the studies carried out in this series was to study the features of changes in the immune status indicators before and after intense training loads aimed at developing special stamina in high-level wrestlers. When analyzing the results obtained in the studies, it was found that the level of lymphocytes before exercise was 21.07±0.45%, and after exercise, an increase in the number of leukocytes in peripheral blood up to 25.07±0.22 % was observed. It is also in line with the criteria for the formation of adaptive responses to training in athletes (Figure 3).

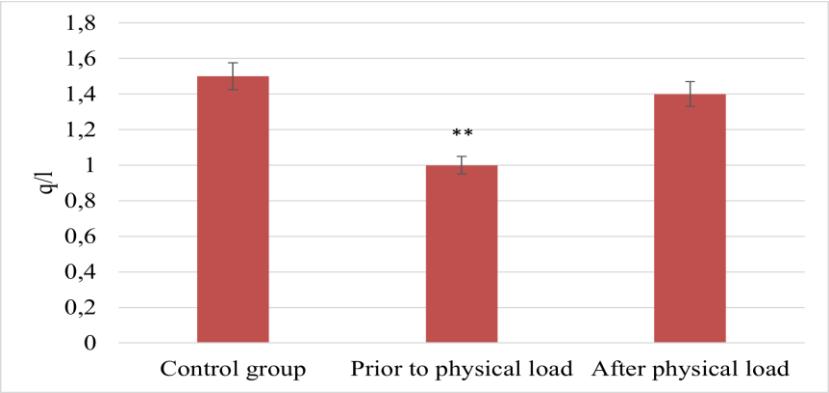

Figure 3. Changes in cellular immunity parameters, specifically the basic immune regulation constant (BIC), in the examined athletes (n=6) following exposure to a single physical activity session.

The main constant of immune regulation (MCI) decreased to 1.07 in the examined athletes compared to 1.45 in the control group (Fig. 3). After high-intensity exercise, humoral immunity indices (IgG, IgA, and IgM) showed significant reductions of 26.0% ($p<0.05$), 21.0% ($p<0.05$), and 11.0% ($p<0.05$), respectively, compared to the control group. In contrast, IgE concentration increased by 21.1%. High-intensity exercise also resulted in a significant rise in cytokine levels in the athletes' blood compared to the control group ($p<0.05$), with increases noted in IL-1, IL-2, and IL-8 (Fig. 4). Additionally, it

was observed that immune system indices in athletes remain stable before engaging in large-scale physical exercise, a finding consistent with the conclusions of many researchers[16].

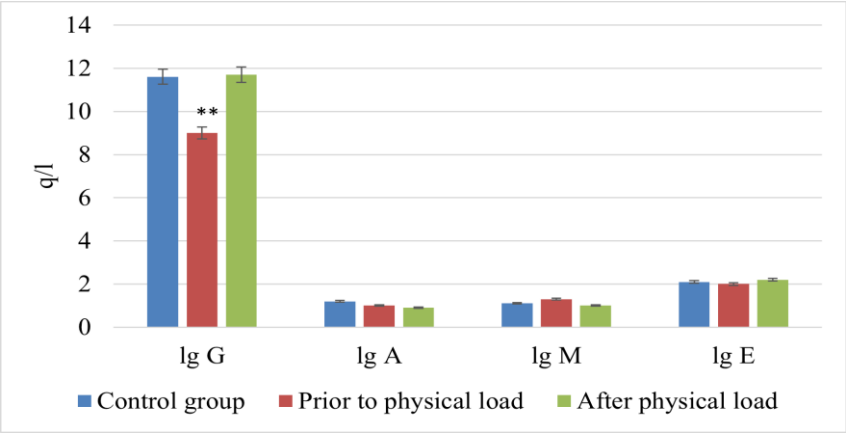

Figure 4. Changes in humoral immunity indices were observed in athletes during single physical exercise.

Thus, the aforementioned findings highlight that the status of the T-system of immunity in athletes remains a subject of debate and warrants more comprehensive investigation. Future studies should consider factors such as age, gender, type and level of sport, sports experience, duration of physical activity, and individual tolerance to training loads to better understand these dynamics.

4. Evaluation of the total oxidant and total antioxidant capacity of the blood of athletes in the same periods of the training and competitive process

The study of the effect of physical activity of varying intensity on the metabolic status and antioxidant protection system of freestyle wrestlers was the main objective of this series of studies. In accordance with the purpose and objectives of the study, the effect of physical activity on the system of lipid peroxidation (LPO) and antioxidant

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protection (AOP) in the blood serum of wrestlers was studied, the results of which are provided in the following tables (Tables 6, 7).

Table 6

The effect of moderate intense physical activity on the indices of lipid peroxidation (LPO) and antioxidant protection (AOP) in the blood serum of wrestlers (M±m)

№	Indicators		Control group (n=6)	Wrestler	
				1st group	2nd group
1	DC, mkmol/l	M±m	54,4±2,7	53,1±2,6	65,6±3,3*
		%	100	98	121
2	MDA, mkmol/l	M±m	23,4±1,2	22,0±1,2	26,7±1,4
		%	100	94	114
3	KAT, mkat/sl	M±m	18,6±0,9	17,5±0,9	20,8±1,1
		%	100	94	112
4	SOD, ME/mqHb	M±m	2,7±0,15	2,5±0,12	2,8±0,15
		%	100	93	104
5	K, c.u.	M±m	3,8±0,2	3,6±0,19	3,6±0,19
		%	100	95	95

Note: * - p< 0.05; ** - p<0.01 compared to the control group

The initial indicators of the LPO system and AOP did not differ significantly in comparison with the control group at the beginning of the training period. On the contrary, significant differences were observed in the studied indicators at later stages of education (p<0.01). As can be seen from the results of changes in the parameters of the LPO and AOP systems in the blood of athletes after exposure to training loads, it was known that the enzymes of the LPO and AOP systems significantly differ in the blood serum according to the levels of physical activity. It was found at this time, that the LPO and AOP systems did not significantly differ in all groups of athletes compared to the control group before the start of the training period. At the end of the preparatory period of the training process after the completion of the training loads, all the studied indicators of the LPO system and AOP had no significant changes compared to the control group. Analysis of the results obtained after the impact of physical loads applied during the competition showed that there are significant changes in the blood serum of freestyle athletes in the level of lipid

peroxidation and the AOP system[17,18] ($p<0.001$). Among these metabolites, the concentrations of DK and MDA in blood serum increased significantly, and there was a significant change in the activity of catalase and SOD, which are antioxidant enzymes. The greatest increase in the concentration of lipid peroxidation products (LPO) and the activity of antioxidant enzymes in the blood serum was at the end of the competition period and at the beginning of the transition period. Significant changes in metabolic processes are observed during the period of intense competition. This is expressed in an increase in lipid peroxidation and antioxidant protection. The smallest changes occurred during the preparation period when it was not affected by physical activity. The severity of metabolic processes in wrestlers directly depends on the training loads performed. If negative changes in the metabolic status occur at the peak of the macrocycle, then the smallest changes occur under the influence of moderate loads. This gives rise to an opinion that moderately intense physical activity does not cause any negative changes in the health of wrestlers, and by regulating the course of adaptation, they create conditions for strengthening immunity[19,20,21].

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Thus, results obtained in the course of the studies may be used as a criterion in building training regime for adolescents and young athletes who wish to engage in wrestling. Furthermore, it can be also used in implementing medical-biological control over metabolic circumstances happening in organism during the training period of wrestlers.

Table 7

The effect of high-intensity training loads on the indices of the LPO and AOM systems in the blood serum of wrestlers (M± m)

Indicators		Control group, n=6	Training periods					
			Preparation period		Competition period		Transition period	
			1st group, n=5	2nd group, n=6	1st group, n=5	2nd group, n=6	1st group, n=5	2nd group, n=6
DK, mkmol/l	M± m	54,4±2,7	52,7±2,5	59,7±3,0	53,5±2,8	65,1±3,2 *	53.3±2,6	74,1±3,6 **
	%	100	97	110	98	120	98	136
MDA, mkmol/l	M± m	23,4±1,2	21,6±1,3	24,7±1,2	22.4±1,2	28,1±1,4 *	22.9±1,0	31,1±1,5 **
	%	100	92	106	96	120	98	133
KAT, mkat/s.l	M± m	18,6±0,9	17,9±1,1	19,8±1,0	18,0±0,9	22,5±1,1 *	17.8±0,8	25,8±1,2**
	%	100	96	106	97	121	96	139
SOD, ME/mqHb	M± m	2,7±0,15	2,7±0,17	2,7±0,2	2,8±0,15	2,95±0,15	2.45±0,15	3,2±0,16*
	%	100	100	100	104	109	91	119
K, c.u.	M± m	3,8±0,2	3,5±0,18	3,85±0,2	3,6±0,19	3,7±0,19	3,7±0,18	3,8±0,19
	%	100	92	101	95	97	97	100

Thus, the results of this study can serve as a valuable criterion for designing training regimens for adolescent and young athletes aspiring to engage in wrestling. Moreover, these findings can be utilized for medical and biological monitoring of the metabolic state during wrestlers' training, ensuring optimal performance and health management.

CONCLUSIONS

1. The duration of the barbell and Gench tests, measured during maximal and submaximal wrestling training, showed an increase in wrestlers compared to the control group. These results suggest enhanced hypoxia tolerance as a physiological adaptation to wrestling training in athletes.

2. Lipid profile parameters in wrestlers, including concentrations of total cholesterol, triglycerides (TG), and low-density lipoprotein cholesterol (LDL-C), were lower compared to the control group. However, increased training intensity did not significantly influence these levels, indicating a limited impact of training progression on lipid metabolism.

3. A significant decrease in cholesterol (TC) levels was observed in 1st-class wrestlers with a muscular body type. A reduction in triglycerides (TG) was more pronounced in athletes with asthenoid and thoracic body types, while a decrease in low-density lipoprotein (LDL-C) levels was consistent across all somatotypes.

4. Seasonal changes of the year significantly affect the state of the immune status of and own cyclical character. Regardless of the period of the training process, immunosuppression is manifested by a decrease in spring, while the immune status indicators increase again in summer, it goes up to a maximum level in autumn, and declines again in winter. However, seasonal changes in the immune status affect the nature of physical loads applied in each training period. The cross interaction of physical loads affecting the body of wrestlers and seasonal environmental conditions has an impact over the number of leukocytes in the peripheral blood, which may be important for the effective organization of anaerobic and aerobic training loads in individuals for various categories of wrestling.

5. After the performance of large-scale training loads, indicators of cellular and humoral immunity affect the decrease in the main classes of immunoglobulins in C_4 and T-cells, and lead to the increase in inflammatory and anti-inflammatory cytokines. Although this case properly reflects the state of functional dynamics occurring in the immune status, it is temporary and does not require immune-correction.

6. Analysis of the results of the implemented studies justified such a conclusion that, significant changes were observed in the LPO level and in the AOP system ($P<0.001$) after exposure to intense training loads in the blood serum of freestyle wrestlers. Consequently, the concentration of MDA, DCK which are metabolites of lipid peroxidation, significantly increased in the blood serum, and the activity of catalase and SOD, which are antioxidant enzymes, have been exposed to the reliable alterations. Such changes were more significant at the end of the competitive period and at the beginning of the transitional period of the training process.

7. The use of **Elton P**, vitamin C, vitamin E, and **Se-active** as biologically active food supplements during wrestlers' training has a tonic effect on the body. These supplements enhance immunomodulatory and antioxidant activity, promote recovery and adaptation to physical exertion, and improve physical performance. They also shorten rehabilitation periods and strengthen the immune system, effectively reducing the intensity of oxidative processes induced in the blood.

PRACTICAL RECOMMENDATIONS

1. When organizing and conducting medical and biological examinations over athletes, special attention should be paid to the state of allergic indicators, since, although they have high adaptive capabilities to intense physical loads, they are classified as a risk group due to the development of allergic diseases.

2. It is assumed that the results obtained in the analysis of changes in the body's immune system caused by physical activity in athletes will be useful in assessing the response of immunological mechanisms to various types of stress reactions.

3. The results obtained from this research can be utilized as experimental material for developing training programs and implementing corrective measures. By integrating these findings, it is possible to significantly enhance the efficiency of training time by minimizing the occurrence of illnesses among athletes, thereby optimizing their overall performance and health.

4. It has been established that the use of "Elton P" and "Se-active" as biologically active food supplements during the training process of high-class wrestlers is safe for the body. These supplements are recommended for use by athletes following large-scale and high-intensity physical activity to support recovery and overall well-being.

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LIST OF ABBREVIATIONS

VC - vital capacity of lungs
AOPS - antioxidant protection system
AOP - antioxidant protection
LDL CH - low-density lipoprotein cholesterol
PIC - participants of international competitions
DC - diene conjugants
SC - stamina constant
DP - dystolic pressure
Harvard-step test (HST)
MCI - main constant of immune regulation
MS - master of sports
KAT - catalase
MVB - Minute volume of blood circulation
LPO - lipid peroxidation
MDA - malondialdehyde
MOC - Maximum oxygen consumption
PWC_{170} - Physical work capacity
SI - Skibinsky index
SOD - superoxide dismutase
ST - systolic pressure
TBT - thiobarbituric acid
TG - triglycerides
TC - total cholesterol
HR - heart rate
HDL CH - high-density lipoprotein cholesterol

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