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STUDY OF THE IMMUNE SYSTEM PARAMETERS IN WRESTLERS AT DIFFERENT STAGES OF THE TRAINING PROCESS

The objective of this study was to identify the effect of the training process on the parameters of the immune system in wrestlers at various stages of training. It was established that in the preparatory and competitive periods of the training macrocycle, under the effect of physical loads in athletes, the total content of CD3 + -, CD4 + -, CD8 + – lymphocytes decreases in the peripheral blood with the formation of a relative hyper suppressive variant of the immunodeficiency state. There is no complete normalization of the parameters of the subpopulation composition of lymphocytes in the transition period. The inclusion of an additional transitional period in the training macrocycle contributes to a more complete recovery of the studied indicators. The use of restorative agents in the transitional period of the training process not only contributes to the optimization of several immune indicators of wrestlers, but also significantly reduces the impact of the seasonal factor on those wrestlers. The biggest effect of recovery measures happens in the spring, the optimization of the immune status of moderate severity took place in the winter and summer periods of the year. It should be mentioned that in the transition period of the training cycle of a significant reduction in intense physical and mental stress in wrestlers, the correction of the immune status with the help of a complex of rehabilitation measures was effective, regardless of the season with a maximum effect in the autumn.

Key words: immunity, physical loads, athletes, lymphocytes, wrestlers, cellular immunity.

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Жаттыру процесінің түрлі кезеңдеріндегі бауырлардағы иммундық жүйе параметрлерін зерттеу

Бұл зерттеудің мақсаты жаттығулардың әртүрлі кезеңдеріндегі балуандардағы иммундық жүйенің параметрлеріне жаттығу процесінің әсерін анықтау болды. Жаттығудың макроциклінің дайындық және жарыс кезеңдерінде физикалық белсенділіктің әсерінен спортшыларда салыстырмалы гиперсупрессиялық варианттың түзілуімен шеткергі қанда CD3 + -, CD4 + -, CD8 + – лимфоциттердің жалпы мөлшері төмендейтіні анықталды. иммун тапшылығы жағдайы. Өтіп бара жатқанда. Өтпелі кезеңде лимфоциттердің субпопуляциялық құрамының параметрлерінің толық нормалануы жоқ. Оқыту макроцикліне қосымша өтпелі кезеңді енгізу зерттелген көрсеткіштердің толық қалпына келуіне ықпал етеді. Жаттығу процесінің өтпелі кезеңінде қалпына келтіретін агенттерді қолдану балуандардың бірқатар иммундық көрсеткіштерін оңтайландыруға ықпал етіп қана қоймайды, сонымен қатар оларға маусымдық фактордың әсерін айтарлықтай төмендетеді. Қалпына келтіру шараларының ең үлкен әсері көктемде орын алады, қалыпты ауырлықтағы иммундық жағдайды оңтайландыру жылдың қысқы және жазғы кезеңдерінде орын алды. Айта кету керек, жаттығу циклінің өтпелі кезеңінде балуандардағы қарқынды физикалық және психикалық стресстің айтарлықтай төмендеуі, қалпына келтіру шаралары кешенінің көмегімен иммундық жағдайды түзету маусымға қарамастан тиімді болды. максималды әсер күзде.

Түйін сөздер: иммунитет, физикалық белсенділік, спортшылар, лимфоциттер, палуандар, жасушалық иммунитет.

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Изучение параметров иммунной системы у борцов на различных этапах тренировочного процесса

Целью настоящего исследования явилось выявление влияния тренировочного процесса на параметры иммунной системы у борцов на различных этапах подготовки. Было установлено, что в подготовительном и соревновательном периодах тренировочного макроцикла под влиянием физических нагрузок у спортсменов в периферической крови снижается абсолютное содержание CD3+ -, CD4+ -, CD8+- лимфоцитов с формированием относительного гиперсубрессорного варианта иммунодефицитного состояния. В переходном периоде не происходит полной нормализации показателей субпопуляционного состава лимфоцитов. Включение в тренировочный макроцикл дополнительного переходного периода способствует более полному восстановлению изучаемых показателей. Использование в переходном периоде тренировочного процесса восстановительных средств способствует не только оптимизации ряда иммунных показателей борцов, но и существенно снижает влияние на них сезонного фактора. Наибольшой эффект восстановительных мероприятий имеет место весной, оптимизация иммунной статуса средней степени выраженностьи имела место в зимнем и летнем периодах года. Надо отметить, что в переходном периоде тренировочного цикла существенного снижения интенсивных физических и психических нагрузок у борцов, коррекция иммунного статуса при помоши комплекса восстановительных мероприятий было эффективной, независимо от сезона года с максимумом эффекта осенью.

Ключевые слова: иммунитет, физические нагрузки, спортсмены, лимфоциты, борцы, клеточный иммунитет.

Introduction

In modern life circumstances, million people are engaged with physical culture and sport and their number is growing day-by-day. Such exercises essentially reduce morbidity, increase life expectancy and the body's resistance to various kinds of adverse environmental factors. However, modern sport of the highest achievements is sometimes associated with loads on the limit of a person's physiological capabilities, and under these conditions, the incorrect organization of the training process, its insufficient individualization, the combination of sports training with intense work and study, even in the presence of compensated defects in health, can lead to the emergence of pathological conditions. To the opinion of some experts, the sickness rate of highly qualified athletes has been growing in recent years [1-6].

We are well informed regarding the important role of immunity in maintaining the constancy of the internal environment of the body, in maintaining homeostasis and, at the same time, the role of immunological mechanisms in the formation of several diseases. Immunity enables protection for the internal constancy of the body from microorganisms and other outsider cells and micromolecules, from a wide variety of genetically other substances. Considering the significant role of the immune system in maintaining homeostasis mechanisms, it is relevant to study the immune status of athletes. Within long and intense physical loads, they may experience serious fluctuations in the parameters of immunity from the phagocytic, T- and B-cell links [4-6], which in certain cases leads to the development of secondary immune-deficiency conditions that limit physical performance [2]. Distractions in the function of the nervous and immune systems are one of the important factors in the imbalance of neurohumoral regulation of homeostasis in general. There is a relationship between motion activity and the function of the immune system, which is controlled by the endocrine system [2; 7].

Certain data was revealed regarding the cellular and molecular mechanisms of the effect of physical loads on the immune system [8-9]. VA. Kolupaev (2009) describes the link between the immune status of athletes with the nature of the energy supply of muscle activity. Thus, when making a clarification regarding the relationship between physical activity and the function of the immune system, it is necessary to consider not only the presence of stress, but also the nature, that is, stress leads to an increase (eustress) or depression (distress) of the immune system. So, R.S. Suzdalnitsky et al. [9] determined the main phases of the immune system reaction, which consequently arise from activation, compensation (stabilization), decompensation, and

recovery stresses. A significant inhibition of most of the studied humoral, secretory, and cellular parameters of immunity is recorded in the phase of decompensation, which indicates a failure of adaptation, depletion of immunity reserves, called "stress immunodeficiencies", which are secondary immunodeficiencies. It was found that the titers of immunoglobulins and "normal antibodies" are reduced to zero, that is, there is a functional paralysis of the immune system. This circumstance has been called "the phenomenon of disappearing antibodies and immunoglobulins".

Currently, it is generally recognized that actual immunological reactions, the state of the T- and B-immunity systems own particular importance in against infectious protection [3; 8; 10-11].

The establishment of the research of the T- and B-systems of immunity is one of the unique accomplishments of contemporary immunology. The immune system is one of the same systems as the neurological, circulatory, excretory, etc. systems, as was previously explained. It is made up of peripheral and central lymphoid organs and tissues, which communicate with one another through lymph and blood. The lymphocyte, the main "figure" of the immune system, is a mobile genetic information carrier whose cytoplasm is organized to allow for unrestricted mobility throughout tissues and the ability to sense environmental stimuli through unique molecular structures called receptors. There are approximately 10^{12} such lymphocytes that enter to a wide variety of tissues by penetrating the capillary wall, migrating between endothelial cells. Lymphocytes constantly circulate through the lymphoid organs from the blood to the lymph, such recirculation is their most important property, since it is the recirculating lymphocytes that encounter microorganisms and other foreign cells and particles [12-14].

The condition of the T-system determines the body's capacity for adaptation. Deficits in the T-system are the cause of several illnesses. A component of the immunological monitoring system is the measurement of T-lymphocyte counts and subpopulations' functional activity.

B-lymphocytes are the precursors of antibody-producing cells. All immunoglobulin molecules that are synthesized by one antibody-producing cell belong to the same class. When the antigen reacts with B-lymphocytes bearing specific receptors, with the participation of microphages and T-lymphocytes, a clone of cells arises due to proliferation and differentiation (clonal selection theory of antibody formation). It is worth to mention that immunoblots and large lymphocytes also contribute to the formation of antibodies [4; 12].

As we have already talked regarding this issue, the main functions of the immune system are resistance to infection, removal of old damaged, genetically foreign cells, and prevention of tumor growth. Immunological reactivity is one of the most important mechanisms to ensure homeostasis, both structural and functional unity of the body. Not only the T-immunity system, but also the B-system and humoral immune play a very essential role to ensure relevant immunity to infection and cancerous neoplasms [6; 9].

The differentiation of B-cells takes place directly in the bone marrow, where B-cell precursors mature into pre-B-cells, which are able to synthesize IgM but lack the appropriate receptors on the cell membrane. The emergence of such receptors marks the formation of bone marrow B-lymphocytes in peripheral blood, lymphoid organs, and tissues. In addition to receptors related to immunoglobulins M, G, A, mature B-lymphocytes carry IgD on their surface. B-lymphocytes differentiate into plasma cells, like a factory of immunoglobulin antibodies that provide their synthesis. According to some investigators, B-lymphocytes are divided into subpopulations (subpopulation of B-suppressors) like T-lymphocytes [5; 7-8; 14-15].

Correspondingly, the humoral immune system is represented by B lymphocytes and plasma cells. Upon exposure to antigen, the secretion of specific immunoglobulin antibodies increases. The 5 types (types) of immunoglobulins that have been identified – M, G, A, E, D – have not only structural characteristics but also different clinical significance, which sports physicians should know. As we said, IgA plays a certain role in the local immune state. IgG makes up the majority of immunoglobulins in the blood (about 70 to 75%), with a length less than 1% that of IgD, while IgM makes up about 10%. The production of antibodies to the tissues of real organism – antibody outage is an important index of the function of the B-system of immunity. The disturbance of the state of immunological tolerance, the function of T-lymphocytes-suppressors, associated with increased activity of T-lymphocytes-helpers facilitate the formation of antibodies, therefore, it is appropriate to consider materials on the presence of the role of out antibodies in athletes [2; 16].

The regular growth of sports achievements requires the implementation of training loads of increasing volume and intensity, which makes it more difficult to individualize the training process.

This may become excessive and contribute to the emergence of various diseases while achieving maximum sports results.

Due to the important role of the immune system in maintaining homeostasis, studying the immune status of athletes is essential. Under prolonged and intense physical loads, they may be exposed to severe fluctuations in the immunological parameters of the phagocytic connection of T and B cells, leading in some cases to development of a secondary immunodeficiency state that limits physical activity. As we have already mentioned, moderate loads contribute to the stimulation and normalization of the immune response and reduce the incidence of diseases, while large loads and an unreasonable build-up of training can be disruptive. immune disorders and increased disease incidence. Increasing expertise, level, and duration of training cycles – all these factors influence immune performance.

Therefore, the study of dynamics, changes in the athlete's immune state depending on the duration and intensity of exertion and the development of the classification of stages or "phases" of the condition athlete's stress, immunocompromised state. When studying the causes of immunodeficiency related to sports stress, much attention is paid to the study of metabolic processes.

High levels of metabolism in the context of physical exertion lead to stress on the immune system during the removal of large amounts of breakdown products resulting from redox reactions. The intensification of metabolism in the most immunocompetent cells themselves leads to disruption of the formation and accelerated disintegration of directly immune structures, which contributes to dysregulation of the immune system [2-3]. At the same time, it should be remembered that there are certain genetic determinants that detect the individual threshold level of physical loads for the body of an athlete; the excess of this threshold leads to metabolic and immune disruptions. Another way to say it is that "sports activity serves as the background against which immunity failure is revealed, which is largely associated with a genetic or acquired decrease in stress resistance" [2].

The objective of the study. To investigate the specific features of immune system changes in wrestlers during various periods of training process.

Materials and methods

We examined 40 wrestlers aged 18-22 over three years. For studying the effect of anaerobic and aerobic physical activity on the body of wrestlers, we selected athletes who use exercises of the appropriate direction in their training. The interpretation of the indicators was carried out considering the seasonal conditions of natural light [10-13; 15-16]. In the annual cycle, depending on the nature of changes in the length of the day, 4 qualitatively unique periods of different duration were distinguished. The first period (December-January) with the minimum length of the day is characterized by small values of their daily changes. The second period (February-March) is characterized by a progressive increase in the photoperiod. The third period (April-June) is characterized by an increase in the length of the day. The fourth period (October-November) is characterized by a decrease in the length of the day. The conducted studies covered 4 seasons, excluding the period from July to September, which was due to the training of athletes outside the city (the city of Gusar, the Olympic base of "Shahdag".

During the experiment, the leukocyte blood formula, and characteristics of the functional state of leukocyte subpopulations (phagocytic activity, activity of neutrophils and monocytes, the level of T- and B-lymphocytes) were determined in wrestlers. The methodology for studying the functional state of blood leukocytes is described in detail in the works of L.Ya. Ebert et al. (1993) and V.V. Rybakov et al. (1995).

To carry out the tasks set in the study, we used hematological methods, in order to determine the content of lymphocytes in peripheral blood, and their quantitative and qualitative characteristics. For proper arrangement of the study, the athletes were also divided into 4 periods in training macrocycle: first, pre-competition (preparatory) period, duration – 3 months, with the frequency of training 3 times a week for 2 hours each; second – competitive period, 2-3 days, with the number of sparring 2-6 for the entire duration of the competition; third – transitional period, transitional, lasting 10 days with light training 2 times a week; fourth – additional transitional period, with light training 2 times a week. 8 practically healthy, but not trained men of 18-22 age constituted the control group. The study was carried out while complying with all provisions of bioethics. Blood sampling for the study was carried out at the beginning and at the end of each period (in the first hour after exercise). Lymphocytes were isolated on a ficoll-verogaphine density gradient according to a modified Boyum method [17-18; 19-21]. Determination of the number of total T-lymphocytes, T-helpers (inducers, cytotoxic T-suppressors, natural killers and B-lymphocytes) was carried out by the method of indirect immune

fluorescence using monoclinal antibodies, respectively CD3, CD4, CD8, produced by the research and production center "Medbio-spectrum" (Moscow, RF) Determination of interleukins (IL-2, IL-10), gamma interferon (IFN) was carried out in lymphocyte supernatants using commercial ELISA kits (Medgenix Diagnostics, Belgium). Tumor necrosis factor (TNF) activity in lymphocyte supernatants was determined by a modified Ruff b Gilford method. The cytotoxicity index (CI) was calculated by the formula:

$$IC=\frac{(D_{pract}-D_{control})\cdot 100}{D_{max}}$$

where $D_{maximum}$ – optical density at the maximum lysis of human erythrocytes at a concentration of 4 million/ml.

The derived digital material was processed by generally accepted methods of mathematical statistics, using the dispersion method and correlation analysis.

Results and discussion

The content and quantity of the main subpopulations of peripheral blood leukocytes in wrestlers in different periods of the annual cycle are provided in Table 1.

Table 1 – Influence of training sessions on the number and content of peripheral blood leukocytes in wrestlers (M±m, n=40)

Indicators	Study periods				
	I	II	III	IV	p
Quantity, Leukocytes, x10^9/l	5,95±0,22	5,02±0,14	4,49±0,16	6,10±0,40	<0,001
Content, NF, %	44,25±2,11	42,37±1,46	39,84±1,71	45,46±2,8	<0,01
Quantity, NF, x10^9/l	2,63±0,16	2,11±0,10	1,91±0,11	2,90±0,20	<0,001
Content, MN, %	6,07±0,50	5,73±0,44	6,84±0,58	6,70±0,50	<0,05
Quantity, MN, x10^9/l	0,36±0,05	0,28±0,025	0,32±0,03	0,43±0,4	<0,05
Content, LF, %	45,66±2,67	48,67±1,54	48,94±1,65	44,70±2,9	<0,01
Quantity, LF, x10^9/l	2,72±0,23	2,35±0,90	2,31±0,90	2,92±0,28	<0,05
Note: p – reliability of differences between groups in the corresponding period					

As it is seen from Table 1, the general variation trend in the number of neutrophils in wrestlers was to reduce the level of circulating cells in the spring-summer period and increase the number in the autumn-winter period. Against this background, the observed differences in the dynamics of the level of neutrophils in wrestlers could be associated with the different nature of the neuroendocrine regulation of the functional state of athletes due to the different dynamics of the intensity of their sports training. At the same time, more pronounced changes in the average level of neutrophils in wrestlers could be associated with the phenomenon of cross-adaptation of thermoregulation mechanisms during regular physical exertion, reflecting a higher level of their resistance in athletes whose physical activity is carried out in a natural environment. The absence of differences in the dynamics of the level of monocytes in wrestlers suggests that the main reason for the observed changes was the known hormonal changes in the body, initiated by seasonal fluctuations in environmental conditions [21-22; 25].

Reciprocal variations in the level of lymphocytes in the wrestlers in the 3rd and 4th periods were probably due to the influence of the mechanisms of neuroendocrine regulation of the functional state of the body during the use of anaerobic and aerobic physical loads. Consequently, it can be assumed that the nature of physical activity can have a modifying effect on the seasonal rhythm of the level of lymphocytes. The dynamics of indicators of the functional state of blood leukocytes in athletes in different periods of the year are presented in Table 2.

As it is obvious from the table, during the first half of the year, the dynamics and the level of the absolute index of neutrophil phagocytosis (AINP) in wrestlers were significantly high ($p<0.01$). During the studies conducted in the second half of the year, the differences between the periods were not significant. It can be assumed that, during the period of increasing day length, the mechanisms of neuroendocrine regulation of the functional state of the body in the modes of anaerobic and aerobic loads

had a modifying effect on the level of phagocytic activity of neutrophils.

The main difference between the dynamics of the absolute indicator of monocyte phagocytosis (AILNA) in athletes is the shift of the extremes of this indicator in the annual cycle. In wrestlers, a maximum was observed during the period of a regressive decrease in the length of the day and a period of its minimum values (4th and 1st, respectively) a minimum with a regressive increase in the length of the day (4th period) [20-22; 24].

The specifics of the neuroendocrine regulation of the functional state when using physical activity of anaerobic and aerobic orientation had a significant impact on the nature of changes in the absolute index of lysosomal neutrophil activity (AILNA) during the most intensive increase in day length (1-3 period). During the period of day length decrease, the nature of motor activity, as well as in relation to the absorption function of neutrophils, did not significantly affect the seasonal dynamics of the lysosomal activity of these cells. The dynamics of the absolute index of lysosomal activity of myocytes (AILNA) did not depend on the specifics of the motor activity of athletes and was characterized by a significant decrease in the level in the spring-summer period and its increase in the autumn-winter period. At the same time, in the spring period, the level of this indicator among wrestlers was significantly lower ($p<0.001$).

Table 2 – Dynamics of changes in indicators of the cellular link of immunity (g/l) in wrestlers at various stages of the training process (M±m)

Indicator	Control group	Beginning of the period	End of the period
Preparatory period			
Leukocytes, 10^9/l	6,30±0,04	6,70±0,80	6,90±0,30*
Lymphocytes,10^9/l	1,55±0,07	1,68±0,08	1,60±0,70
Monocytes, 10^9/l	0,32±0,08	0,20±0,10	0,18±0,20*
Neutrophils,10^9/l	2,90±0,02	3,2±0,25	4,05±0,20*
CD3, 10^9/l	0,85±0,07	0,90±0,04***	1,18±,03***
CD4, 10^9/l	0,56±0,04	0,64±0,03***	0,73±0,02***
CD8, 10^9/l	0,42±0,02	23,9±0,8*	0,35±0,01***
Competition period			
Leukocytes, 10^9/l	5,65±0,30	5,60±0,0*	5,20±0,25
Lymphocytes,10^9/l	1,75±0,04	1,70±0,03*	1,60±003
Monocytes, 10^9/l	0,075±0,05	0,04±0,05*	0,09±0,05
Neutrophils,10^9/l	4,80±0,20	3,60±0,3*	4,90±0,20
CD3, 10^9/l	0,53±0,07	0,88±0,03***	0,95±0,03***
CD4, 10^9/l	0,46±0,04	0,53±0,02***	0,75±0,20***
CD8, 10^9/l	0,43±0,02	0,25±0,01**	0,32±0,01***
Transitional period			
Leukocytes, 10^9/l	6,0±0,30	5,62±0,30	5,90±0,30
Lymphocytes,10^9/l	1,35±0,007	1,20±0,06	1,40±0,05
Monocytes, 10^9/l	0,18±0,08	0,15±0,07	0,16±0,07
Neutrophils,10^9/l	3,30±0,20	3,20±0,20	3,0±0,03
CD3, 10^9/l	0,63±0,07	0,72±0,03***	0,88±0,03***
CD4, 10^9/l	0,60±0,04	0,55±0,02***	0,70±0,018***
CD8, 10^9/l	0,45±0,02	0,38±0,01**	0,52±0,01***
Note: * – p<0,05; ** – p<0,01; *** – p<0,001			

Changes in the number of HCT (Hematocrit)-positive neutrophils in wrestlers, the average level of this indicator increased in the autumn-winter period and decreased in the spring-summer period. In wrestlers, the number of HCT-active monocytes significantly changed only during the period of the minimum day length.

The specific characteristics of the change in the level of T-lymphocytes was a significant decrease in this indicator in wrestlers during the period of a stable decrease in the length of the day (4th period). At the same time, in wrestlers, a decrease in the number of T-lymphocytes was due to a decrease in the level of circulating lymphocytes. Significant fluctuations in the level of B-lymphocytes in wrestlers were recorded during the period of shortening of the day. During the period of increasing day length, the level of these cells remained stable.

The carried-out correlation analysis enabled to identify direct links between the amount of physical activity used and indicators of the functional state of blood phagocytosis in athletes. Simultaneously, an inverse relationship was observed between the level of the latter and the parameters of daily illumination. The presence of reciprocal influences from physical activity and seasonal environmental conditions on the state of blood leukocytes, in our opinion, is essential for the rational organization of the training process of anaerobic and aerobic orientation in various sports.

The analysis of the obtained results of the subpopulation composition of peripheral blood lymphocytes of wrestlers in the preliminary and preparatory periods is provided in Table 2.

It was determined that at the beginning of the preparatory period, the absolute content of CD3+ lymphocytes were 1.45 times lower than in the control group ($p<0.001$). Analysis of the subpopulation composition of T-lymphocytes made it possible to highlight the presence of an imbalance in the system of CD4+ – and CD8+ – cells, which corresponded to the relative hypersuppressive variant of secondary immunodeficiency. At the beginning of the preparatory period of the training process, there is a decrease in the number of CD3+ – B-cell lymphocytes and an increase in imbalance in the CD4/CD8 system.

The study of the population composition of lymphocytes of the peripheral composition of wrestlers in the competitive period is presented in Table 2. Indicators of CD3+ -, CD4+ -, CD8+ – lymphocytes at the beginning of the competitive period did not deviate significantly from those at the end of the preparatory period. Re-examination of the immune status at the end of the competitive period allowed us to note that physical activity had a negative effect on the population composition of peripheral blood lymphocytes.

Table 2 provides the results of the study of the population composition of blood lymphocytes of athletes in the transition period. At the beginning of the transition period, the number of CD3+ – lymphocytes increased by 1.35 times compared to the figure at the end of the competitive period ($p<0.05$), however, remained lower than the figure in in the control group by 2.0 times ($p<0.001$), which indicated the persistence of T-lymphopenia. The relative content of these cells at the beginning of the transition period fluctuated within the limits of the values of the control group. At the end of the transition period, the absolute content of CD3+ – lymphocytes was 1.25 times higher than their initial level at the beginning of the period ($p <0.05$) and 1.65 times lower than in the control group ($p <0.001$), which also indicated on the preservation of T-lymphopenia (table 2).

At the end of the macrocycle, all athletes were granted with an additional transitional period of 10 days, at the end of which their immune status was studied (Table 4). It was established that the prolongation of the transition period had a positive effect on the population composition of the peripheral blood lymphocytes of wrestlers. This was expressed in higher absolute numbers of T-, B-lymphocytes and natural killers and in a less pronounced imbalance of the main immunoregulatory subpopulations of T-lymphocytes. The registered absolute numbers of the studied populations of lymphocytes in athletes were significantly higher than those at the beginning of the preparatory period (for CD3+ and CD4+ cells – 1.20 times, for CD8+ – lymphocytes), and higher than those at the end of the transition period (for CD3+ – lymphocytes in 1.30 times, for CD4+ cells 1.40 times, for CD8+ lymphocytes 1.20 times). The CD4/CD8 immunoregulation index at the end of the additional transition period was almost the same as at the beginning of the preparatory period and was 1.2 times higher than at the end of the transition period ($p<0.01$). At the same time, an increase in the duration of the transition period did not lead to a complete normalization of all indicators of the population composition of athletes' blood lymphocytes, the changes of which occurred under the influence of physical activity during the preparatory and competitive periods of the training macrocycle [23-25].

Results of the study of the secretory and cytotoxic activity of peripheral blood lymphocytes of wrestlers during the training macrocycle are presented in Tables 3 and 4.

It has been established that under the influence of physical activity, the functional activity of peripheral blood lymphocytes of athletes decreases, which is expressed in a decrease in the spontaneous secretion of IL(Interleukin)-2, IL(Interleukin)-6, IL-10, TNF (Tumor necrosis factor)-α, TNF (Tumor necrosis factor)-β and gamma (γ)-IFN (Interferon).

Table 3 – Effect of training sessions on cytotoxic and secretory activity of peripheral blood lymphocytes of wrestlers in precompetitive and competitive periods (M±m)

Study groups / Indicator	Control group	Periods	
		Pre-competition	Competition
IL-2, ng/ml	10,80±0,5	8,50±0,30**	4,85±0,15***
IL-6, ng/ml	1,95±0,4	1,46±0,06**	0,85±0,04***
IL-10, ng/ml	1,65±0,05	1,37±0,06*	0,55±0,03***
TNF-α, ng/ml	3,90±0,15	3,35±0,12*	1,76±0,07***
gamma (γ)-IFN, ng/ml	3,37±0,14	2,92±0,10*	1,50±0,06***
TNF-β, ng/ml	7,97±0,8	6,95±0,25*	3,50±0,15***
ИЦ, %	35,8±1,6	29,9±1,07**	21,1±0,67***
Note: * – p<0,05; ** – p<0,01; *** – p<0,001			

Table 4 – Secretory and cytotoxic activity of peripheral blood lymphocytes of wrestlers in the transition and additional transition periods (M±m)

Study groups / Indicator	Control group	End of the period	
		Transitional	Additional transitional
IL-2, ng/ml	10,80±0,5	7,45±0,25***	10,15±0,35
IL-6, ng/ml	1,95±0,1	1,75±0,07*	1,88±0,08
IL-10, ng/ml	1,65±0,05	1,32±0,05***	1,60±0,06
TNF-α, ng/ml	3,80±0,15	3,15±0,12***	3,78±0,15
gamma (γ)-IFN, ng/ml	3,37±0,12	2,50±0,08***	3,25±0,12
TNF-β, ng/ml	7,97±0,4	6,15±0,23***	7,95±0,28
ИЦ, %	35,80±1,6	27,8±1,0***	33,9±1,14
Note: * – p<0,05; ** – p<0,01; *** – p<0,001			

Variations in the secretory and cytotoxic activity of lymphocytes depend on the intensity of physical activity: they are moderate in the preparatory period, the largest in the competitive period, and start declining in the transitional period of the training macrocycle. The inclusion of an additional transitional period in the training process contributes to the complete normalization of the functional activity of lymphocytes.

The indicators of the immune system can go beyond the physiological boundaries and be pathological under the influence of highly physical and psycho-emotional stress, causing an increase in morbidity and a decrease in sports performance. For the rime being it is known that the suppression of individual manifestations of immune defense often does not affect the final resistance of the organism. When reviewing immune disorders in athletes, it is often necessary to consider the role of the processes of fatigue, overwork, overstrain and overtraining. The data obtained are of great practical importance and are consistent with the study of other researchers, who also revealed significant immune changes in both wrestling athletes and athletes involved in middle-distance running and other sports [24-26].

Conclusion

Thus, it was determined that in the preparatory and competitive periods of the training macrocycle under the influence of physical activity in athletes involved in freestyle wrestling, the absolute content of CD3+ -, CD4+ -, CD8+ – lymphocytes in the peripheral blood decreases with the formation of a relative hypersuppressive variant of the immune-deficient state. Immune disruptions are assessed as moderate in the preparatory period and as the greatest in the competition. In the transitional period, there is no complete normalization of the indicators of the subpopulation composition of lymphocytes. The inclusion of an additional transitional period in the training macrocycle contributes to a more complete recovery of the studied indicators. Under the influence of physical activity, the functional activity of peripheral blood lymphocytes of athletes decreases, which is expressed by a decrease in the spontaneous secretion of IL-2, IL-6, IL-10, TNF-α, TNF-β and gamma (γ)-IFN, as well as a decrease in cytotoxic activity CD16+ – cells. Variations in the secretory and cytotoxic activity of lymphocytes depend on the intensity of physical activity: they are moderate in the preparatory period, the largest in the competitive period, and tend to be declining in the transitional period of the training macrocycle. The inclusion of an additional transitional period in the training macrocycle contributes to the complete normalization of the functional activity of lymphocytes. A thorough immunological examination of the activity of the lymphocyte population of warriors helps to assess the individual's physical activity threshold, the excess of which leads to metabolic and immune disorders. The use of recovery agents in the transition period of training not only contributes to the optimization of some immune indicators of wrestlers, but also significantly reduces the influence of seasonal factors on them. The greatest effect of restorative measures occurs in the spring, optimization of the immune condition of moderate severity occurs in the winter and summer of the year. It should also be emphasized that during the transition phase of the training cycle, the intensity of physical and mental stress in wrestlers is significantly reduced, the regulation of the immune state using a variety of measures recovery worked, no matter the situation. Maximum effectiveness is in the fall. Data collected, processed and extracted during the study will be used to incorporate training sessions into the training process to minimize loss of training time due to reduced wrestler rates. In addition, the results obtained will be useful for the development of non-pharmacological methods to correct cellular immune disorders in athletes participating in spring and winter wrestling.

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