YAKUT MEDICAL JOURNAL 2(46)2014

Morphology of Leukocytes as an Indicator of Yakutia Athletes' Adaptability to Intense Exercises

Semenova E.I., Olesova L.D., Krivoshapkina Z.N., Mironova G.E., Konstantinova L.I., Okhlopkova E.D., Efremova A.V.

ABSTRACT

Hematologic researches of leukogram and nonspecific adaptive reaction of an organism of highly skilled fighters and boxers of Yakutia revealed a loading hypoxia in 30% and organism disadaptation in more than 10% of athletes.

Material for the study was conducted among athletes - single wrestlers of the State high sports skills school, School of Olympic Reserve of the Republic Sakha (Yakutia) and Churapchinsky State Institute of Physical Culture and Sports. 169 athletes Yakuts in age from 18 to 28 years old, involved in acyclic sports were surveyed: 112 freestyle wrestlers and 57 boxers. The control group consisted of 30 students of the North- Eastern Federal University named after M.K. Ammosov, aged 19 to 25 years, engaged in physical training program for general university.

Keywords: athletes, leukogram, loading hypoxia, nonspecific adaptive organism reactions.

INTRODUCTION

Composition of white blood indicates the status of the immune system [12, 14], and is an indirect measure of stress reaction in athletes in assessing the extent of the training load [2, 3]. According to some authors, the composition of white blood cells in norm in athletes is quite stable and varies little over time [13, 14]. However, according to V.I. Boldina (4), one-year dynamics of hematological parameters in conditions of regular muscular loads reflects positive adaptive changes in the blood system of athletes.

Nonspecific adaptation (or anti-stress) response (NAR) is the main body's response to the action of any stimulus [2]. In the basis of NAR differentiation are different levels of neuro- endocrine-immune homeostasis. NAR is defined by the intensity of the processes of accumulation of energy and plastic resources in the body and their expenditure in adapting to complex stimuli, external and internal environment, as well as the reactivity of host defenses, including phagocytosis, immunoreactivity, and the formation of the inflammatory response etc. Ultimately NAR characterizes the degree of intensity of metabolism in the adaptation process and the body's resistance to the action of the stimulus for a short time and in the future. It is known that going for

great sport is accompanied by intense exercise loads and leads to a breach of the general condition and the frequent development of stress that causes a decrease in immuno-biological reactivity and occurrence of disease [5, 9].

Adaptive response in athletes often does not correspond to the characteristics of health. These blood tests given in the literature [2, 3], speak for the predominance of intense training and activation reactions or stress, as well as reactivation. Particularly tense are reactions before - and competitive periods [8]. Therefore, a study of the morphological composition of white blood and NAR in elite athletes in the conditions of Yakutia, where climatogeographic factors lead to increased stress on the human body, is important.

The purpose of the study. To assess leukogram peripheral blood and nonspecific adaptive response (NAR) in elite athletes Yakutia.

MATERIALS AND METHODS

Material for the study was conducted among athletes - single wrestlers of the State high sports skills school, School of Olympic Reserve of the Republic Sakha (Yakutia) and Churapchinsky State Institute of Physical Culture and Sports. 169 athletes Yakuts in age from 18 to 28 years old, involved in acyclic sports were surveyed: 112 freestyle wrestlers and 57 boxers. The control group consisted of 30 students of the North- Eastern Federal University named after M.K. Ammosov, aged 19 to 25 years, engaged in physical training program for general university.

Peripheral blood corpuscles per unit volume (1mkl) levels were measured on a hematology analyzer with integrated semi dilutor - NA-5710 (made in USA) using reagents firm JTBAKER (Netherlands).

In vitro the following parameters were determined in peripheral blood: WBC (White Blood Cell, WBC).

Nonspecific adaptive response (NAR) of athletes- single wrestlers was determined by leucocyte procedure Garkavi L.H. (2006).

RESULTS AND DISCUSSION

Average white blood indices of athletes - single wrestlers are within acceptable normal values (Table 1). Comparative analysis of data athletes- single wrestlers and the control group showed statistically significant difference in the total number of leukocytes, lymphocytes and monocytes. Thus, in the control group, these figures were lower than those of athletes - single wrestlers, while in the athletes - single wrestlers number of monocytes varied within the upper limit of normal. Significant differences were found in relative and absolute terms, nuclear neutrophils and monocytes in absolute terms, wrestlers and boxers. In the boxers these figures were higher than in

the fighters (Table 1). Lowering of the total number of white blood cells (leukopenia) was detected in 4.46% of wrestlers and 3.5% of boxers, and an increase (moderate leukocytosis) - at 4.46% of wrestlers and 5.26% of boxers (Table 2). Differential leukocyte analysis revealed relative segmentonuclear neutropenia in 16.07% of wrestlers and 24.56% of boxers and absolute segmentonuclear neutropenia in 10.52% of boxers. Relative lymphocytosis was observed in 23.21% of wrestlers and 28.07% of boxers, and absolute lymphocytosis in 6.25 and 7.02% respectively (Table 2). The study results do not contradict the published data. According to Zh.I. Karpova [et al.] (6), changes in the number and properties of leukocytes and lymphocytes are one of the first responses of an athlete organism to excessive exercise. At fatigue the number of leukocytes increases, in this case the so-called "myogenic leukocytosis" with phase change is revealed [10]. Above outlined leukocyte changes are observed also in our sportsmen. Thus, the first lymphocytic phase with distinct rise in the number of lymphocytes (40-50%) at a relatively small increase in the total number of cells (up to 9000-1000) and with relative neutropenia were observed in the two wrestlers. Neutrophilic leukocytosis with phase (up to 10,000), with an absolute neutrophilia and relative lymphopenia was detected in 3 fighters and 1 boxer, and with relative eosinophilia – in 1 boxer. Muscle leukocytosis (up to 11000) relative and absolute monocytosis was detected in 1 wrestler. However, the relative and absolute eosinophilia, without increasing the total number of leukocytes, was ascertained in 20% of wrestlers and 14% of boxers. Relative and absolute monocytosis was detected in 28% of wrestlers and 43% of boxers, and the relative and absolute lymphocytosis was observed in 27% of wrestlers and 35% of boxers.

It is known that during intense physical exertion of submaximal power (wrestlers and boxers) many metabolites, unoxidized decay products are formed - low molecular weight acids (lactic, pyruvic, etc). Accumulation of acids in muscle cells alters the properties of their internal contents, obstructing the course of the process of muscle contraction. Under such conditions, the cell tends to get rid of acid, giving them to blood. Penetration of large amounts of acids in blood leads to change in important biological constants - the acid - alkalinity (pH) of blood. Reduced blood (pH) changes the properties of blood proteins and is a threat to their destruction. At the same time the rate of formation of acids during submaximal power is so high that the buffer system of the blood do not have time to neutralize acidification, which subsequently leads to hypoxic conditions.

It was experimentally proved that any effects of hypoxic stress in the early stages of character and increasing tissue hypoxia is the activation of mononuclear phagocytes of the bone marrow, monocytosis and therefore is non-specific reaction to any stress effect [11]. Increasing the load on the system - increasing rate of oxygen consumption and CO2 production, which is observed in the

amplification function of the organ or tissue, especially at muscle activity also affects the system as a whole, for all its units. Hypoxic conditions, arising by increasing the load on the system, i.e., with a significant increase in oxygen consumption, are allocated in a separate type - load hypoxia [7].

According to our data the relative monocytosis is ascertained at 5.25% of wrestlers and 10.52% of boxers, and the absolute monocytosis - in 25.89 and 33. 33% of sportsmen (Table 1).

Nonspecific adaptive response of the body (NAR) is the basic response of the organism to the action of any stimulus. Depending on the nature of the stimulus to the body such a specific adaptive response is formed (e.g., to the action of cold - increased heat release, dilution of cell membranes, skin reactions, etc.). However, this specific reaction only models, directs track nonspecific response of the body. NAR provides at the adaptive process energy resources, plastic materials for the synthesis of the necessary enzymes and other cellular structures, the level of activity of protective systems and regulation of the entire metabolism. NAR character depends on the ratio of the intensities of the stimulus and the response of an organism. At the basis of NAR differentiation are different levels of neuro-endocrine-immune homeostasis [2].

NAR is defined by the intensity of the processes of accumulation of energy and plastic resources in the body and their expenditure in adapting to complex stimuli, external and internal environment, as well as the reactivity of host defenses, including phagocytosis, immunoreactivity, formation of inflammatory reactions, etc. Ultimately NAR characterizes the degree of intensity of metabolism in the adaptation process and the body's resistance to the action of the stimulus for a short time and in the future.

It is known that modern sport involves significant physical and emotional stresses that cause stress on the athletes' body. Therefore, in the long-term adaptation of an athlete is formed, both general and specific mechanisms of adaptation. Under these extreme conditions, for the body's athletes natural defense, more acceptable is calm NAR and increased activation.

Results of the nonspecific adaptive response (NAR) study are shown in Table 3. At the impact of potent factors to the organism or stress reaction (characterized by severe lymphopenia - less than 20%), or the reactivation reaction develop.

As seen from Table 3, in the reaction characterized as calm and increased activation were over 60% wrestlers and boxers, and also 90% of non-athletes, with NAR levels being on average reactivity. Calm and increased activation NAR of the average reactivity body is characterized by the following features: in the blood test there are small deviations from the normal of one or two elements of leukocyte formula. Blood coagulation is normal at a quiet activation and at elevated - moderately reduced.

According to the literature from the CNS side at a quiet activation moderate physical excitation is observed, and more pronounced - at higher excitation. Emotional state at a quiet activation is good, while at increased activation - excellent. At calm activation efficiency of the organism is good on a length, but a little worse for speed. At elevated activation, conversely, operability is great for speed, but inferior in durability. Endocrine glands in calm activation is active secretion of glucocorticoids (anti inflammatory-hormones) is within the lower half of the limit of normal and at elevated - secretion of glucocorticoids is on 10-30% above normal. The immune system is good. High resistance of the organism. Plastic and energy metabolism are well balanced, anabolic processes (synthesis) predominate. Both the activation reactions (especially increased) stimulate and enhance the activity of the body's defense. At these reactions is the fastest and adequate protective forces restructuring in response to the damaging effects [1, 2].

According to our data the reaction “high reactivity stress” was detected in 4.46 % of wrestlers and 5.26 % of boxers, and reactivation was observed in 10.71% and 12.28 respectively. This reaction of the organism to the NAR is characterized as follows: in the CNS inhibition prevails, emotional state is satisfactory , the average activity, operability is slightly reduced for speed , there is a sleep disorder, apathy, reduced appetite, secretion of glucocorticoids is moderately increased, the activity of cellular immunity is slightly below normal, humoral - within the normal range, the body's resistance is slightly reduced, metabolism - energy and plastic - slightly violated, catabolism prevails(but not dramatically) (breakdown). This type of reactivity is observed in violation of general health and premorbid conditions.

At reactivation coagulation is slightly reduced. From the CNS marked agitation is observed. Greatly enhanced sensitivity. Unstable emotional state. The mood is good, but there is anxiety and stress with symptoms of irritability and aggressiveness. Disturbed sleep - difficult to fall asleep and waking up in the night. Great appetite. Especially increased activity of cellular immunity. Moderately lowered body resistance. Plastic and energy metabolism is very active, accelerated anabolism (synthesis) and catabolism (breakdown), but anabolism prevails. This reaction is not a disease, but there are health and sleep disorders. Biological sense of reactivation is in attempt of the body to keep the activation in response to an impossible burden without the "reset" in stress. Reactivation is better than stress, but it's dangerous by «breakdown» into it, besides reactivation is nonspecific basis of certain diseases.

Thus, in highly skilled Yakutia athletes relative segmented neutropenia was detected in 16.1% of wrestlers and 24.6% boxers, and absolute segmented neutropenia - in 10.5 % of boxers. Relative and absolute eosinophilia was ascertained in 20% of wrestlers and 14 % of boxers. Identified in

28% of wrestlers and 43% of boxers relative and absolute monocytosis and relative and absolute lymphocytosis in 27% of wrestlers and 35% of boxers, and increasing of all agranulocytes (monocytosis + lymphocytosis) without increasing the total number of leukocytes, occurring in 11% of wrestlers and 14 % of boxers show nonspecific adaptive response of the organism due to the occurrence of stress hypoxia.

Nonspecific adaptive reaction of the organism in athletes is characterized by stress response in 4.46% of wrestlers and 5.26% of boxers and the reactivation in 10.71% of wrestlers and 12.28% of boxers, which is organism disadaptation to physical stress.

REFERENCES

1. Tatkov O.V. [et al.] Aktualnyie problemyi vosstanovitelnoy meditsinyi, kurortologii i fizioterapii [Actual problems of regenerative medicine, health resorts and physiotherapy]. St. Petersburg, 2004, 42 p.
2. Garkavi L.H. [et al.] Antistressornyie reaktsii i aktivatsionnaya terapiya [Antistress reactions and activation therapy]. Yekaterinburg: Philanthropist, 2002, Part 1, 196 p.
3. Garkavi L.H. Antistressornyie reaktsii i aktivatsionnaya terapiya [Antistress reactions and activation therapy]. Yekaterinburg: Philanthropist, 2003, Part 2, 36 p.
4. Boldina V. I. Dinamika vodnogo balansa krovi pri srochnoy i dolgovremennoy adaptatsii k myishechnyim nagruzkam [Dynamics of water balance in the blood at term and long-term adaptation to muscular exercise]. avtoref. dis. ... kand. biol.nauk a [author. dis. ... Cand. biol.sci.]. Moscow, 1993, 16 p.
5. Dembo A.G. Sportivnaya kardiologiya. Rukovodstvo dlya vrachey [Sports Cardiology. Guide for Physicians]. Leningrad: Medicina, 1989, 64 p.
6. Karpova Zh.I. Ispol'zovanie pokazateley beloy krovi dlya kontrolya za perenosimostiu fizicheskih nagruzok [Using white blood indicators for exercise tolerance monitoring].Teorija i praktika fizicheskoj kul'tury [Theory and practice of physical culture], №6, 1987, p.40-42.
7. Kolchinskaya A.Z. Gipoksicheskaya trenirovka v sporte [Hypoxic training in the sport]. Gipoksikal Medical. ed. A.Z.Kolchinskaya, 1993, N2, p.36.
8. Konovalov V.N., Nechaev V.I., Barbashev S.V. Marafon: teoriya i praktika [Marathon: theory and practice].Omsk, 1991,163 p.

9. MarischukV.L. Serova L.K. Informacionnye aspekty upravleniya sportsmenom [Information aspects of athlete management]. Moscow, FIS, 1983.

10. Rozhentsov V.V., Polevschikov M.M. Utomlenie pri zanyatiyah fizicheskoy kul'turoy i sportom: problemy, metody issledovaniya [Fatigue during physical education and sport: problems, research methods]. Moscow, Soviet Sport, 2006, 280 p.

11. Ulitko M. V. Rol' monocitov-makrofagov v adaptivnyh reakciyah krovetvornoy tkani pri deistvii na organizm ekstremal'nyh faktorov [Role of monocyte-macrophages in adaptive reactions of hematopoietic tissue under the action of extreme factors on the organism:], diss. ... kand. biol. nauk [diss. ... Cand. biol. Scie]. Ekaterinburg, 2008, 183 p.

12. Banfi G., Del Fabbro M., Mauri C. Haematological parameters in elite rugby players during a competitive season / G. Banfi, M. Del Fabbro, C. Mauri // Clin. Lab. Haematology. - 2006. - V. 28. -P. 183-188.

13. Courts A. J., Wallace L. K., Slattery K. M. Monitoring Changes in Performance, Physiology, Biochemistry and Psychology during Overreaching and Recovery in Triathletes / A. J.Courts, L. K. Wallace, K. M. Slattery // J. Sports Med. - 2007. - V. 28. - P. 125-134.

14. Silva A.S.R., Santhiago V., Papoti M. Hematological parameters and anaerobic threshold in Brazilian soccer players throughout a training program / A.S.R. Silva, V. Santhiago, M. Papoti //Int. J. Laboratory Hematology. - 2008. - V. 30. - P. 158-166.

15. Pedersen B.K., Hoffman-Goettz L. Exercise and the immune system: regulation, integration, and adaptation / B.K.Pedersen, L. Hoffman-Goettz //Physiological reviws. - 2000. - V. 80. -P. 1055-1081.

Table 1

Morphological composition of the blood of athletes

(Significance of the differences represented non-parametric Wilcoxon-Mann-Whitney)

	WBC· 10^9/l	Basophils (%)	Eosinophils (%)	Stab neutrophils (%)	Segmented neutrophils (%)	Lymphocytes (%)	Monocytes (%)
Wrestlers n = 112	6,2±0,1^{x} p=0,01	0,1±0,02	2,7±0,1	1,1±0,3* p=0,005	51,6±0,6	36,0±0,6	8,5±0,2^{x} p=0,005
	Absolute figures	3,9±1,02	167,4±11,5	65,3±27,9* p=0,005	3230,7±82,8	2167,7±49,6^{x} p=0,04	518,8±14,9*^{x} *p=0,05 ^{x}p=0,000
Boxers n=57	6,4±0,1^{a} p=0,008	0,1±0,02	2,8±0,2	2,7±0,5* p=0,005	50,8±0,8	36,0±0,8	8,9±0,3^{a} p=0,001
	Absolute figures	6,1±1,4	188,4±15,3	193,6±37,3* p=0,005	3303,6± 110,573	2293,8±66,3^{a} p=0,03	563,9±19,9*^{a} *p=0,05 ^{a}p=0,000
Control group n=30	5,27±0,59^{xa} ^{x}p=0,01 ^{a}p=0,008	0,0±0,0	2,4±0,9	1,2±0,5	55,9±2,9	34,8±2,7	5,7±0,6^{xa} ^{x}p=0,005 ^{a}p=0,001
	Absolute figures	0,0±0,0	124,5±36,4	59,9±23,3	2950,0±360,6	1847,5±273,0^{xa} ^{x}p=0,04 ^{a}p=0,03	294,4±39,8^{xa} ^{x}p=0,000 ^{a}p=0,000

Note: * - The wrestlers and boxers, ^{x}- wrestlers and control group, ^{a}- boxers and control group

Table 2

Leukocytes Deviations depending on the sport *

Blood counts	Indicators reduction		Indicators increase	
	Wrestlers n=112	Boxers n=57	Wrestlers n=112	Boxers n=57
WBC	4,46	3,5	4,46	5,26
Eozinotsitoz relative	-	-	8,92	7,02
Eozinotsitoz absolute	-	-	11,6	8,77
Segmented neutropenia relative	16,07	24,56	-	-
Segmented absolute neutropenia	-	10,52	-	-
Segmented relative neutrophilia	-	-	3,57	1,75
Relative lymphopenia	4,46	1,75	-	-
Lymphopenia absolute	6,25	5,26	-	-
Relative lymphocytosis	-	-	23,21	28,07
Absolute lymphocytosis	-	-	6,25	7,02
Monocytosis relative	-	-	5,25	10,52
Monocytosis absolute	-	-	**25,89**	**33,33**

* Percentages (%) of the number of examinees

Table 3

Indices of nonspecific adaptive reaction of an organism (NAR) in athletes (%) *

	Wrestlers	Boxers	Control group
Stress	**4,46**	**5,26**	0
Training	16,07	14,03	6,67
The activation of tranquil	20,53	29,82	**46,67**
Increased the activation	**46,43**	**38,59**	**43,33**
Reactivation	**10,71**	**12,28**	3

* - Percentages (%) of the number of examinees

Information about the authors:

1. Semenova E.I., candidate of biological sciences, junior research assistant, FGBI "Yakut Scientific Center of complex medical problems" SB RAMS, Sergelyakhskoe Highway 4, 677010, Yakutsk, Russia, kunsuntar @ mail / ru;

2. Olesova L.D., candidate of biological sciences, senior research assistant, FGBI "Yakut Scientific Center of complex medical problems" SB RAMS, Sergelyakhskoe Highway 4, 677010, Yakutsk, Russia;

3. Krivoshapkina Z.N., candidate of biological sciences, senior research assistant, FGBI "Yakut Scientific Center complex medical problems" SB RAMS, Sergelyakhskoe Highway 4, 677010, Yakutsk, Russia;

4. Mironova G.E., Sc.D., professor of, head. lab. CIM NEFU named after M.K.Ammosov, research assistant, FGBI "Yakut Scientific Center of complex medical problems" SB RAMS, Sergelyakhskoe Highway 4, 677010, Yakutsk, Russia;

5. Konstantinova L.I., junior research assistant, FGBI "Yakut Scientific Center of complex medical problems" SB RAMS, Sergelyakhskoe Highway 4, 677010, Yakutsk, Russia;

6. Okhlopkova E.D., candidate of biological sciences, junior research assistant, FGBI "Yakut Scientific Center complex medical problems" SB RAMS, Sergelyakhskoe Highway 4, 677010, Yakutsk, Russia;

7. Efremova A.V., candidate of biological sciences, junior research assistant, FGBI "Yakut Scientific Center complex medical problems" SB RAMS, Sergelyakhskoe Highway 4, 677010, Yakutsk, Russia.