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THE LEVEL OF STEROID HORMONES IN THE BODY OF WRESTLERS AT DIFFERENT PERIODS OF THE TRAINING CYCLE IN THE CONDITIONS OF THE NORTH

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The aim: to assess the level of steroid hormones in the Yakut freestyle wrestlers in the pre-competitive and recovery period in the spring season. The levels of testosterone, dehydroepiandrosterone, dehydroepiandrosterone sulfate and cortisol in the blood serum of highly qualified athletes and university students who go in for physical education at least 2 times a week were studied. The lower testosterone content in wrestlers revealed before the competition indicates the intensity of training loads and psycho-emotional stress. A slight increase in testosterone levels after 7-10 days and its excess of the basal level after 30 days after the competition indicates the adequacy of recovery. The level of cortisol is characterized by a significantly lower content before the competition, and a continuing decrease after the competition in the second period (p=0.027; p=0.003) than in the control group. A similar character of changes in the level is also observed in relation to DHEAS. Levels of all steroid hormones 30 days after the competition, exceeding their pre-competition levels, indicates adaptation to stress and shows the recovery of the body. The growth of the T/K index in athletes 7-10 years after the competition indicates the beginning of recovery processes in the body. A higher level of testosterone, cortisol and DHEAS (p = 0.003) - the hormone of the precursor of these hormones one month after the competition indicates a moderate activation of the pituitary-adrenal system to balance the processes of anabolism and catabolism.

Keywords: steroid hormones, cortisol, testosterone, DHEA, wrestlers, training cycle period.

In modern sports, growing physical activity increases neuropsychic stress. Their joint influence with climatic and environmental factors of the North on the body of athletes causes the summation of stress effects that activate metabolic processes. In such conditions of training, an adequate process of adaptation to physical loads becomes relevant for maintaining the performance of athletes and achieving high results.

An important role in maintaining homeostasis in the process of adaptation to physical activity is played by the endocrine system, which regulates anabolic and catabolic processes in the body, where sex hormones play an important role.

Anabolic processes mean the processes of synthesis of substances necessary for the organs and systems of the body. Regenerative processes and anabolism of muscle tissue are dependent on the level of hormones, including testosterone. Its main role is to induce the synthesis of contractile proteins in muscles undergoing strenuous exercise. Also, during competition, testosterone may be needed to mobilize functionality [17].

In parallel, catabolic processes occur in the body - the breakdown of cells and tissues, the decomposition of complex structures with the release of a large amount of energy. Strong physical loads during training and competitive periods can become catabolic stress, causing changes in the hormonal status of the body [12]. An excessive increase in the level of cortisol causes the breakdown of muscle cells, disrupts the delivery of amino acids to them, thereby reducing the athlete's performance. It is known that the nature of hormonal changes depends on the level of fitness of the body, load parameters and the duration of the recovery period [1, 6].

Excessive activation of the pituitary-adrenal system can cause disruption in the functioning of organs, imbalance of various systems and depletion of the functional reserves of the body. Therefore, it is necessary to evaluate the effect of physical activity on the body in different periods of the training cycle [4].

The purpose of this study was to assess the level of steroid hormones in Yakut freestyle wrestlers in the pre-competitive and recovery period.

Material and research methods. The study was conducted in the spring period from March to April 2019. A total of 40 young men aged 17 to 23 were examined. The first group consisted of 18 freestyle wrestlers, candidates for master of sports (CMS) of the Republican School and the College of the Olympic Reserve. The average age was Me-18 (18; 19). The second group included 22 NEFU students. M.K. Ammosov, who go in for physical education at least twice a week. The average age was Me-19 (18; 22).

Blood sampling from all subjects was carried out in the morning hours (8-10 hours) on an empty stomach from the cubital vein into a vacutainer with a coagulation activator, in a state of relative muscle rest. The athletes were examined at different periods of the training cycle, the

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1st stage - 10-14 days before the competition, the 2nd stage after 7-10 and the 3rd stage 30 days after the competition. Students involved in physical education 2-3 times a week, blood sampling was carried out once in the interval between the beginning of the recovery period of athletes. The analysis was carried out in blood serum by enzyme-linked immunosorbent assay (ELISA) using standard kits, on a Uniplan photometer (Pikon, Russia). Determination of the level of hormones cortisol (K), testosterone (T) and dehydroepiandrosterone sulfate (DHEA-s) was carried out using standard kits "AlkorBio" (Russia) and dehydroepiandrosterone (DHEA) - DBC company (Canada), according to the manufacturer's instructions.

The study was approved by the decision of the Local Ethics Committee at the Federal State Budget Scientific Institution "YSC CMP" and carried out with the informed consent of the subjects in accordance with the ethical standards of the Declaration of Helsinki (2000).

Statistical processing of the obtained data was carried out using the SPSS Statistics 26 statistical software package. Continuous values were presented as a median (Me) and an interquartile range of 25 and 75%. To identify the relationship between the studied indicators, the method of correlation analysis of data was used with the calculation of coefficients and Spearman's rank correlation. Significance of differences was determined by Student's t-test and ANOVA for independent groups. The critical value of the level of statistical significance of differences (p) was taken equal to 5%.

Results and discussion. Analysis of the obtained data showed that the average values of steroid hormones in all the examined groups were within the reference values (table 1). It was found that the content of anabolic hormones testosterone and DHEA did not have significant differences in all groups, but the range of DHEA concentrations in some athletes, especially at the pre-competitive stage, was slightly higher than in the group of students. However, in wrestlers at the pre-competition stage (10-14 days before the competition), the testosterone level tended to be lower in comparison with its content in the student group and after the competition stages after 7-10 and 30 days (Table 1).

Freestyle wrestling belongs to the group of martial arts, where mainly the speed-strength qualities of athletes are developed. At the pre-competitive stage of training, athletes train harder and perform longer exercises, the nature of which stimulates a decrease in testosterone. A number of authors noted a decrease in testosterone levels in men during prolonged physical exertion [15, 20, 21]. In addition, an increase in the level of testosterone in the blood serum was not observed in athletes during endurance training [9]. In the work of Nikanorov A.A. the average serum testosterone level in young Yakut men (18–28 years old) with a normal BMI (18.5–24.9 kg/m^2) was 22.9 ± 8.24 nmol/l [11].

Synthesis and secretion of testosterone are regulated by luteinizing (LH) and follicle-stimulating hormones FG of the pituitary gland. Prolonged exercise or exercise has been shown to increase cortisol levels while maintaining LH levels while decreasing testosterone levels in men. When modeling a stressful state with reduced physical activity (immobilization), a decrease in testosterone secretion occurs along a different pathogenetic pathway. In this case, corticoliberin blocks luliberin cells, which, accordingly, leads to inhibition of the synthesis of LH and testosterone. One of the possible mechanisms for reducing the testosterone content, not associated with the secretion of gonadotropins, is considered to be a shift in metabolism towards catabolic processes over anabolic ones as a result of cortisol hypersecretion [3].

It is assumed that if athletes whose physical activity requires endurance continue their training sessions, testosterone concentration decreases as a result of dysfunction of the hypothalamus or an increase in cortisol levels, which suppresses cortisol secretion [17].

At the second and third stages, 7-10 and 30 days after the competition, there is a tendency to increase the level of testosterone, compared with the pre-competition period, which is probably associated with a decrease in training loads and psycho-emotional stress at the recovery stage (Table 1). With intense physical activity and adequate recovery, an increase in testosterone levels and a decrease in cortisol levels were recorded [13]. In one study, an increase in testosterone levels in the recovery period relative to baseline was noted in skiers [2]. In the absence of normal recovery, the level of both total testosterone and its free fraction decreases.

The level of DHEA-S at the pre-competition stage for 10-14 days did not have significant differences with the group of students, but was significantly reduced at the second stage of the training cycle 7-10 days after the competition by 14.2%, compared with the group of students (p= 0.041) and increased at stage 3 30 days after the competition by 32.2% compared with stage 2 p=0.003 (Table 1).

Analysis of the data obtained did not reveal significant differences in the content of cortisol in the blood serum of wrestlers at different stages of the training cycle (Table 1). The average level of cortisol in the group of wrestlers before (for 10-14 days) and after the competition (after 7-10 days) was lower in comparison with the group of students (p=0.027; p=0.003, respectively) (table). Our data do not contradict the literature data. One study showed that a decrease in fasting serum cortisol levels after submaximal cycling in wrestlers compared to skiers and control subjects was noted, this is due to the fact that in this case, physical activity led to a decrease, providing, possibly, elimination hormones from the blood. And later, throughout the entire period of the study, the concentration of

Table 1

Indicators of the level of steroid hormones in wrestlers and students Me (25%Q1 -75%Q3)

Hormones (reference values)	Students (n =22)	Wrestlers		
		Stage 1 (n =18)	Stage 2 (n =17)	Stage 3 (n =17)
T (12,1-38,3 nmol/l)	30.64 (26.06; 36.83)	25.18 (19.26; 32.84)	29.42 (26.40; 34.19)	33.44 (21.54; 37.02)
K (150,0-660,0 nmol/l)	568.84 (516.77; 624.70)	540.28$^+$ (490.27; 559.82) p=0.027	522.14$^+$ (426.94; 542.00) p=0.003	560.21 (531.25; 603.00)
DHEA (3,0-11,0 mcg/ml)	5.10 (4.33; 5.89)	5.91 (4.56; 8.25)	4.77 (3.92; 7.57)	5.91 (4.51; 7.27)
DHEA-S (1,0-4,2 mcg/ml)	2.46 (2.09;3.43)	2.41 (2.07; 3.35)	2.11$^+$ (1.56; 2.38) p=0.041	3.11* (2.08; 4.06) p=0.003

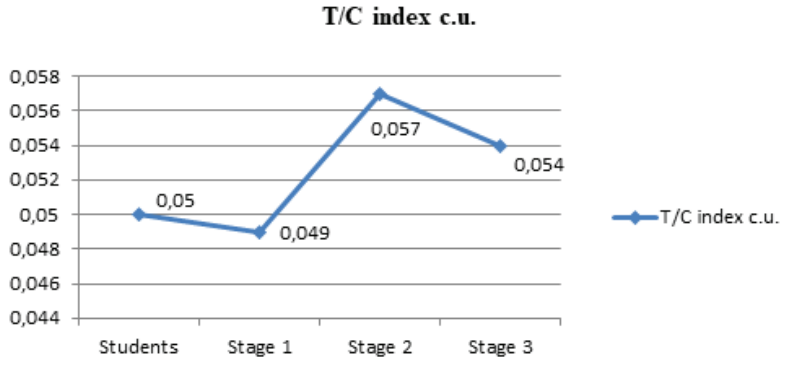
Note: + in comparison with the control group, * - in comparison with the 2nd stage, after the competition in 7-10 days.

cortisol in the blood serum on an empty stomach in wrestlers was significantly lower compared to the background [2].

In the group of wrestlers, a slight increase in the level of cortisol was noted at the 1st pre-competition stage 7-10 days before the competition and the 3rd recovery stage 30 days after the competition, compared with the 2nd post-competition period (after 7-10 days) (Table 1.). A higher value of cortisol at the pre-competitive stage of training is an adaptive response and a good indicator of the fitness of the body and is associated with the psycho-emotional state of some athletes. There are publications that indicate the relationship between pre-competitive cortisol concentration and good performance in martial arts [16], as well as a positive correlation with the psycho-emotional state, self-confidence and anxiety [14, 19]. The previous increase in cortisol concentration, most likely, reflects the psychological mechanisms that provide an increase in the athlete's precompetitive excitement and are part of the mechanism for increasing readiness to overcome the stress associated with the upcoming fight. A slight increase in cortisol contributes to increased physical performance and performance. Its excessive activation is an unfavorable factor and has a negative impact on the athlete's body, leading to the tension of adaptive reserves and showing fatigue and overtraining. In addition, an excessive increase in cortisol affects bone and muscle tissue, sleep, the cardiovascular system, immunity, endocrine regulation, weight change, and glucose regulation. As a result, with significant overloads and overtraining syndrome, the ratio of anabolism and catabolism hormones (testosterone/cortisol) changes with the prevalence of the latter [8].

Taking into account all these data, in order to identify the degree of stress of the studied body systems and its regulatory systems in the recovery process at different periods of the training process, the testosterone/cortisol index was determined. There is an increase in the ratio of the T/K index among athletes during the recovery period, after the competition (after 7-10 days) in comparison with the group of students and the period 10-14 days before the competition (p=0.013; p=0.024).

Correlation analysis showed a direct relationship between testosterone levels and cortisol levels (r = 0.363; p = 0.001), T / C index (r = 0.761; p = 0.000) and DHEA (r = 0.330; p = 0.004), a direct relationship was also revealed concentrations of DHEA with the level of



Changes in the T/K index of wrestlers at different stages of the training cycle:
+ in comparison with students, * in comparison with the 1st stage, before the competition (10-14 days)

Table 2

Dependence of steroid hormones in young wrestlers and students

Hormones	Ro Spearman	T	K	T/K	DHEA	DHEA-S
T	Correlation coefficient Value (two-sided) N	1.000 . 74	0.363** 0.001 74	0.761** 0.000 74	0.380** 0.001 74	0.121 0.306 74
K	Correlation coefficient Value (two-sided) N	0.363** 0.001 74	1.000 . 74	-0.155 0.188 74	0.454** 0.000 74	0.159 0.177 74
T/K	Correlation coefficient Value (two-sided) N	0.761** 0.000 74	-0.155 0.188 74	1.000 . 74	0.141 0.232 74	0.90 0.446 74
DHEA	Correlation coefficient Value (two-sided) N	0.380** 0.001 74	0.454** 0.000 74	0.141 0.232 74	1.000 . 74	0.540** 0.000 74
DHEA-S	Correlation coefficient Value (two-sided) N	0.121 0.306 74	0.159 0.177 74	0.90 0.446 74	0.540** 0.000 74	1.000 . 74

Note: ** Correlation is significant at the 0.01 level (two-tailed); *correlation is significant at the 0.05 level (two-tailed)

cortisol (r=0.454; p=0.000) and DHEAS (r=0.540; p<0.000), which confirms the regulation of anabolic processes over catabolic ones is associated with an increase in steroid hormones (Table 2).

DHEA is a hormone with androgenic activity, has an anabolic effect and is responsible for the development of secondary sexual characteristics. 90% of the hormone is produced in the adrenal cortex, the remaining 10% is synthesized in men in the testes, in women in the ovaries. The precursor of DHEA is cholesterol. In turn, DHEA is converted into other steroid hormones. In the body of men, DHEA is converted into stronger androgens: testosterone and androstenedione [7].

Neurosteroids (DHEA) and its sulfated form (DHEAS) are mainly synthesized by the adrenal cortex and partly in the brain tissue and are of great interest. [5,18]. In the brain, DHEA and DHEA-S regulate glucocorticoid activity and protect nervous tissue from high doses of cortisol. Activation of the hypothalamic-pituitary-adrenocortical system leads to the release into the systemic circulation of many steroid hormones, including DHEA, which is metabolized to DHEA-S with a pronounced antiglucocorticoid effect. It has been reliably confirmed that DHEA has such effects as anti-stress, antidepressant, immunomodulatory, which are essential for a person to maintain health and active longevity. Since DHEA is a biochemical substrate for the further synthesis of sex steroid hormones (testosterone and estrogens) and undergoes intracrine metabolism with the formation of testosterone and/or estradiol in the cells of a number of organs

and tissues, some authors suggest that DHEA deficiency in men can lead to testosterone and estrogen deficiency. [10].

Low DHEA values are more often associated with insufficient adrenal function. Chronic stress and disease can lead to a decrease in DHEA, indicating adrenal stress syndrome. DHEA works in many ways as a synergistic twin of another stress hormone, cortisol. This helps the body adapt more effectively to stress. Stress can be anything: physical, mental and emotional, but its impact is always long-term. For example, studying that is given to a person with difficulty or exhausting conditions at work can become a source of serious health problems.

DHEA-S is synthesized primarily as the sulfate ester from the cholesterol sulfate ester. DHEA-S undergoes hydrolysis, thereby maintaining a constant level of DHEA in the blood plasma.

Conclusion. The results of the study of the dynamics of the hormonal response to physical and mental stress at different stages of the training cycle revealed the features of the adaptive restructuring of the hormonal background, in connection with the sports activities of wrestlers. At the pre-competition stage (10-14 days before the competition), when wrestlers adapt to psychophysiological and physical loads, the level of steroid hormones with anabolic effect testosterone, DHEA and DHEAS remains unchanged, the cortisol level decreases p=0.027, in comparison with the group of students involved in physical education 2 times a week, which indicates a high level of physical fitness and good adaptation of the body. At the recovery stage (after 7-10 days of the competition) there is a significant increase in the T/K index p=0.013 and a significant decrease in the level of cortisol in athletes, in comparison with the control group, p=0.003 and the pre-competitive stage p=0.024, which indicates an increase in anabolic effects and efficiency of recovery processes in the body. A relatively high level of steroid hormones testosterone, DHEA, a significant increase in DHEAS (p = 0.003) and an insignificant decrease in the T/K index in comparison with the recovery stage in wrestlers 30 days after the competition indicates a high adaptation of the body to physical exertion and moderate activation pituitary-adrenal system to balance the processes of anabolism and catabolism.

Assessment of hormone levels in athletes in different periods of the training cycle requires an individual approach to identify ambiguous changes in the stress of adaptive capabilities, fatigue and overstrain.

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