PHYSIOLOGICAL EFFECT OF LIGHT WATER FUNCTIONAL STATE OF HIGHLY TRAINED ATHLETES

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Water plays a decisive role in the origin and life of plants, animals and humans. It is not only the basis of the liquid media of the human body, but also a direct participant in all biochemical processes of its life. Water is universal solvent for polar molecules, since it is able to break almost all types of molecular and intermolecular bonds and form solutions. The functions of water in the body cannot be overestimated, and the main ones are maintenance the constancy of the internal environment, ensuring thermoregulatory processes, transport of substances through cell membranes and the vascular wall, provision of digestive and excretory functions, participation in the regulation of osmolality of liquid media.

It is believed that the purer the water, the more efficiently it performs its functions. But the concept of water purity is much deeper than just the absence of pollution and harmful impurities. It is known that natural water is heterogeneous in molecular composition: along with the usual "light" molecules, it contains other "heavier" molecules consisting of heavy hydrogen and oxygen atoms. After the discovery of heavy water, academician N.D. Zelinsky wrote in 1935: “Who would have thought that there is still another water in nature, which we did not know anything about until last year, water, which we daily introduce into our body in very small quantities together with drinking water. However, a small amount of this new water consumed by a person during his life is already a value that cannot be ignored ”[1]. When studying the biological effects of heavy water, it was found that in its pure form it is a poison for all life on Earth. Even with a large dilution (35 times), heavy water is capable of causing irreversible changes in the body of higher animals, which lead to their death. The use of water with an increased concentration of heavy molecules leads to pronounced toxic effects at the level of the body [2].

For the first time, Soviet scientists B.N. Rodimov and IV Toroptsev in the 60s of the twentieth century [3]. The hypothesis served as the basis for conducting research on the properties of "light water", i. e. water with a reduced content of heavy molecules-isotopologues relative to the natural level [4], [5]. Works of scientists from the Institute of Biomedical Problems of the Russian Academy of Sciences showed that "light water" is a necessary component of the life support system of astronauts during long flights [6], [7].

However, the question of the influence of "light water" on the functional state of athletes has not yet been studied, although it has great scientific and practical significance. In this regard, the purpose of this study was to study the effect of "light water" on the functional state of highly trained athletes.

RESEARCH METHODS

The survey involved 20 volunteer athletes, men aged 18-34 years, professionally involved in sports. As drinking water, he proposed "light water" - "AquaSLEP", obtained by the method of vacuum rectification and isotopic composition identical to natural water of antarctic ice. Content heavy Deuterium-containing molecules in it were reduced 1.6 times compared to natural deionized water, the latter serving as a "control" water. Both water samples were equally remineralized in accordance with the norms of physiological usefulness of macro- and microelement composition to a total mineralization level of 250 mg / l. Permitting documents for the use of "light water" were presented to the ethical commission of the Research Institute of Normal Physiology named after P.K. Anokhin, Russian Academy of Medical Sciences, which approved the use of "light water" in as drinking water for athletes. Thus, the study of the effect of "light water" on the functional state of athletes was carried out in compliance with bio-ethical standards.

During the course (28 days), the subjects were asked to drink "light water", however, they took "light water" in different modes, depending on which the subjects were divided into 3 groups:

- Group 1 - "Light water" (7 people) - took "light water" randomly, for 28 days daily in accordance with the individual need.
- Group 2 - "Light water" (7 people) - took "light water" randomly, for 28 days, dosed daily at 600 ml per day.
- Group 3 - "Test water" (6 people) - drank ordinary drinking water, packaged in the same dishes as "light water", randomly for 28 days. The subjects were not informed that this was ordinary water.

Before the start of the study, the subjects were explained the purpose, objectives and regulations of the study, familiarized with the permits for "light water", after which they gave written voluntary consent to participate in the experiment. Before and after the course of taking "light water", the subjects of all groups were assessed the psychological and vegetative status, blood tests were carried out.

The assessment of the psychological status of the subjects was carried out both on the basis of a psychological questionnaire, where the subjects were offered the SAN questionnaire and the Spielberger test in order to assess their well-being [8] and the level of situational anxiety [9].

To assess the vegetative status, an ECG was recorded (I, II, III leads) for 5 minutes using the Poly-Spectrum-8 complex (Neurosoft, Ivanovo). On the basis of the cardiointervalogram, the heart rate (HR, beats / min) was calculated, and the indicators of heart rate variability were calculated. A spectral analysis of the heart rate was carried out on the basis of the fast Fourier transform calculated as the total power of the spectrum (Tp, ms 2), and spectral powers in three frequency ranges (in ms 2 and in% of Tp): high-frequency - HF, low-frequency - LF, ultra-low-frequency - VLF [10]. In addition, blood pressure was measured using an AND UA-767 automatic meter (Japan) (ADS, ADP, mm Hg). Based on the values of heart rate and blood pressure, the stroke volume of blood (SVV, ml) and the minute volume of blood circulation (MVV, l / min) were calculated [11]. Blood tests were carried out. Clinical and biochemical blood tests, blood tests for immune and hormonal status were assessed,

the antioxidant activity was assessed and anemia diagnosed.

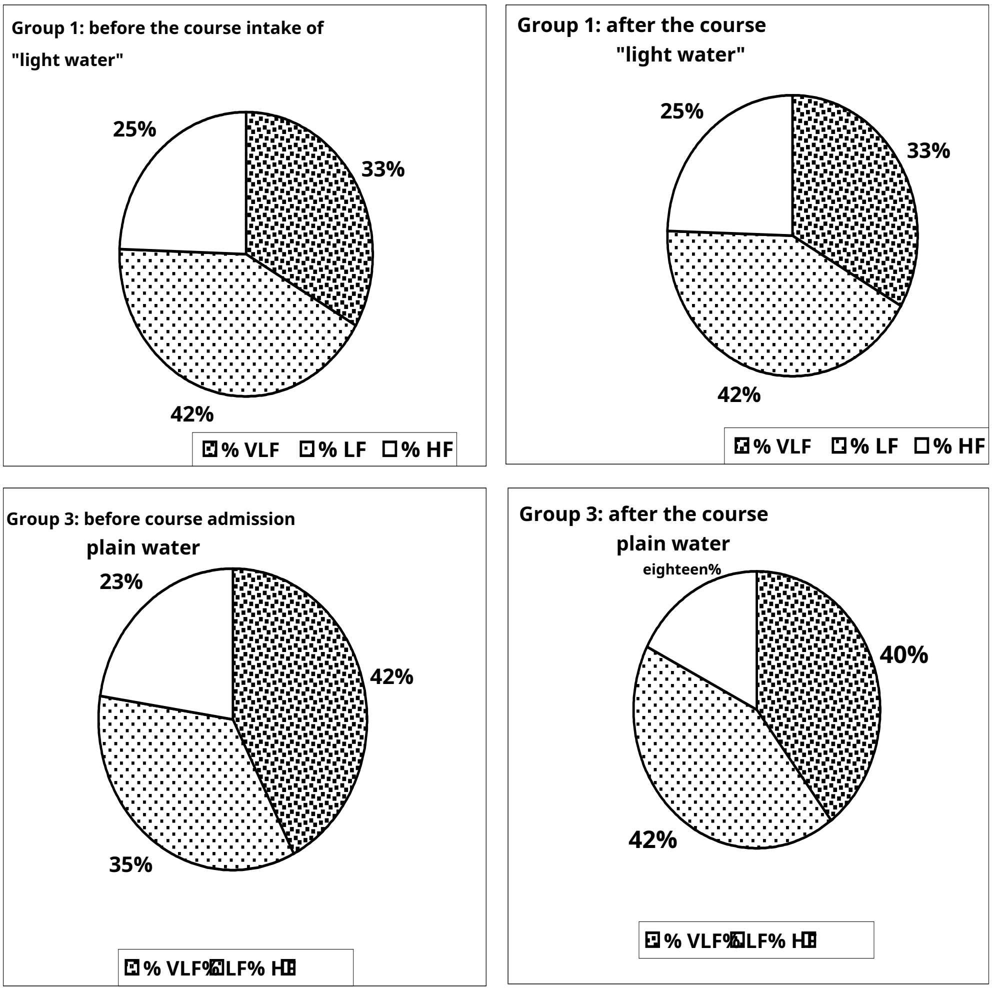
Statistical processing of the obtained indicators was carried out using the STATISTICA 6.0 package. To compare intragroup and intergroup differences used nonparametric criteria Wilcoxon and Mann-Whitney.

RESULTS AND DISCUSSION

The use of "light water" for daily drinking in the selected groups did not reveal significant changes in psychological sphere test subjects. Thus, for athletes of group 1 ("light water") there was a tendency to an increase in subjective well-being from 4.8 ± 0.3 to 5.2 ± 0.2 points and a decrease in the level of subjective anxiety from 36.5 ± 3.1 to 34 , 4 ± 2.5 points. At the same time, the subjects characterized "light water" as tasty and well-quenching thirst.

The effect of light water on the vegetative balance of a person was assessed based on the spectral analysis of the ECG, which showed the absence of significant intergroup differences in all parameters. The spectral components of the heart rate (% VLF,% LF,% HF) in relation to HR before and after drinking water in the subjects of the selected groups are shown in Fig. 1. The figure shows that the examined group 1, who took "light water", practically did not change the ratio of the spectral components in the structure of the heart rate after the course of taking "light water", while the subjects who took ordinary water (group 3) showed a tendency to an increase in the proportion of LF waves from 35 to 42% and a decrease in the proportion of HF waves from 23 to 18%. Last thing testifies *about the enhancement of sympathetic influences on the heart in the subjects of group 3 and the enhancement of their activation of the vasomotor center (SDC) of the medulla oblongata, which is responsible for vasomotor vascular reactions.*

It was shown that neither the intake of "light water", nor the intake of ordinary water caused significant changes in the ECG parameters.



Norms:% VLF = (15-30)%,% LF = (35-40)%,% HF = (15-25)%

Fig. 1. The ratio of the spectral components of the heart rate (% VLF,% LF,% HF) in the surveyed groups 1 and 3 before and after a 28-day course of water intake.

To answer the question: do the properties of "light water" and the volumes of its consumption affect on hemodynamic parameters test subjects spent comparative analysis of hemodynamic parameters. The results of the analysis of hemodynamic parameters are presented in Figures 2-6.

Note that the subjects of groups 1 and 3 had practically the same constitutional parameters and drank daily practically the same amounts of water of different properties (0.96 l of "light water" and 0.89 liters of ordinary water, respectively). After a 28-day intake of "light water" in individuals of group 1, against the background of stabilization of systolic blood pressure (BPS) and a tendency to decrease in diastolic blood pressure (BPP), a tendency to increase in stroke blood volume (SVV, ml) and minute , l / min). In accordance with the research of V.L. Karpman and B.G. Lyubina (1982), an increase in the minute volume of blood circulation can be regarded as an improvement in the utilization of oxygen by tissues and an increase in the physical performance of the subject.

[12]. All this testifies in favor of the improvement of hemodynamic parameters in persons of group 1, who took "light water" in accordance with the individual need. The subjects of group 3, who also took ordinary water in accordance with the individual need, showed a tendency towards an increase in systolic blood pressure (BPP).

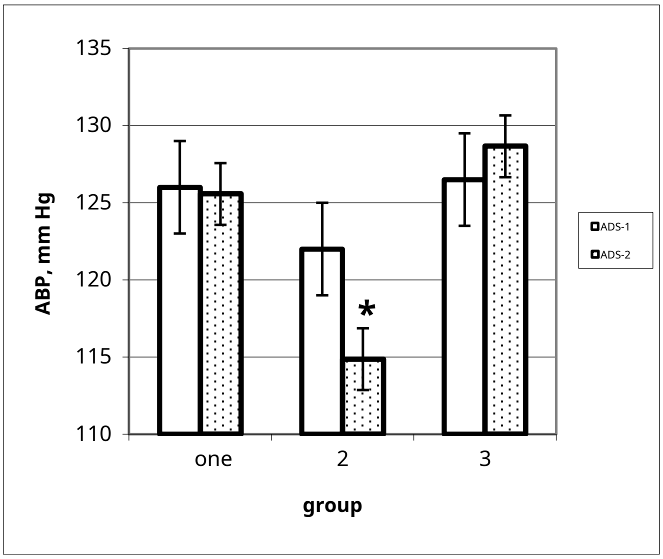


Fig. 2. The mean values of systolic blood pressure (BPS) before drinking water (light bars) and after drinking (shaded bars) in subjects 1, 2 and 3 of groups. An asterisk indicates significant differences ($p < 0.05$) in the indicator.

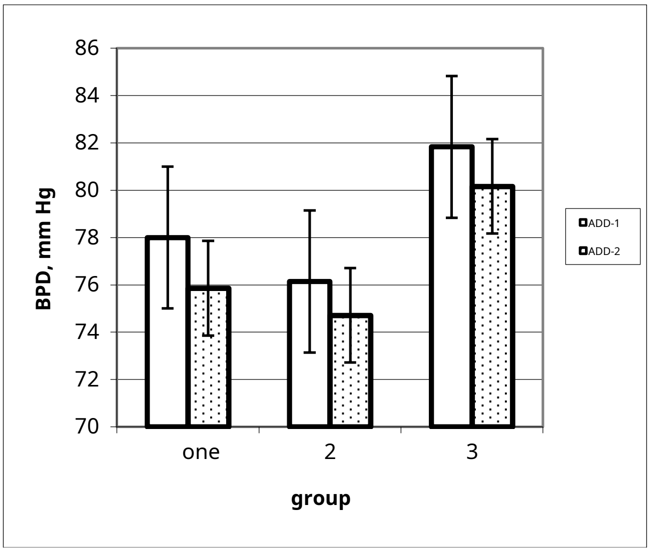


Fig. 3 Average values of diastolic blood pressure (BPP) before drinking water (light bars) and after drinking (shaded bars) in subjects of groups 1, 2 and 3.

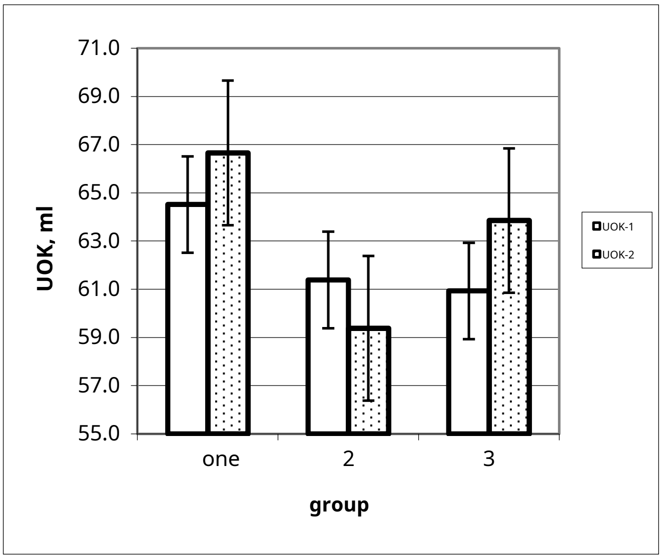


Fig. 4 Average values of stroke volume of blood (SVV) before (light bars) and after (shaded bars) drinking water in subjects of groups 1, 2 and 3.

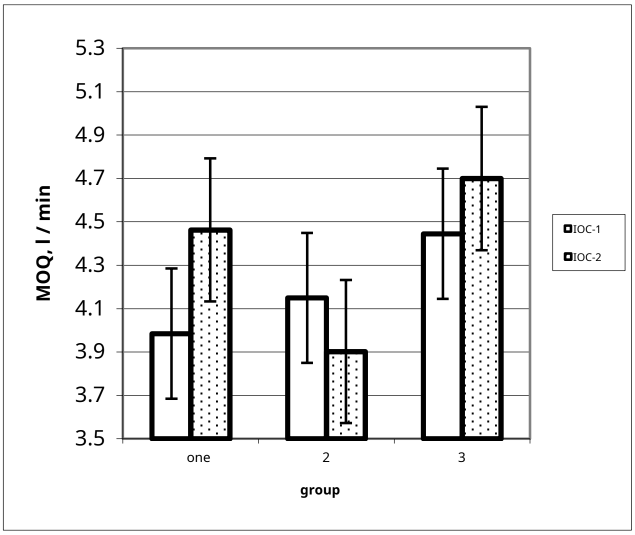


Fig. 5 Average values of the minute volume of blood flow (MVV) before (light bars) and after (shaded bars) drinking water in subjects of groups 1, 2 and 3.

We carried out a comparative analysis of hemodynamic parameters in the tested groups 1 and 2. Note that both groups drank "light water", however, if group 1 drank about 1 liter of "light water" daily, then group 2 drank less of it, namely 600 ml. As a result, after a 28-day intake of "light water" in group 2 individuals, there was a significant decrease in blood pressure ($p < 0.05$), a tendency towards a decrease in blood pressure, blood pressure and blood volume, and a decrease in blood pressure and blood volume clearly indicates a deterioration in hemodynamic parameters physical performance. Thus, the consumption of "light water" in the amount of about 1 liter per day improves hemodynamic parameters and creates conditions for the growth of physical performance in observed persons, while consumption of the same water in smaller volumes (600 ml per day), on the contrary, worsens hemodynamic parameters blood circulation. *These data in aggregate testify in favor of the intake of large volumes of "light water" as a means of maintaining the hemodynamic parameters and the level of physical working capacity of athletes.*

The question arises whether the properties of drinking water ("light water" or ordinary water) affect blood counts. Note that, unlike ordinary water, "light water" does not contain deuterium and chlorine. A comparative analysis of blood parameters was carried out in persons taking "light water" (combined group 1 and 2, 14 people - "Light water") and taking ordinary water (group 3, 6 people - "Control water"). Table 1 shows the average values of these indicators before and after a course (28 days) of water.

Table 1

Average values of blood parameters before and after a course of water intake

Indicator, units measurements	Range norms	Time control	Light water	Control water	Intergroup differences
Clinical analysis					
Hemoglobin, g / l	130-160	before admission	144.1 ± 4.7	152.8 ± 7.4	
		after taking	146.2 ± 4.3	152.7 ± 6.0	
Erythrocytes, 10 · E12 / l	4.0-5.0	before admission	5.2 ± 0.1	5.4 ± 0.2	
		after taking	5.1 ± 0.1	5.4 ± 0.1	
Hematocrit,%	40-48	before admission	44.7 ± 1.3	46.3 ± 2.0	
		after taking	44.0 ± 1.2	46.2 ± 1.7	
Leukocytes, 10 · E9 / l	4.0-9.0	before admission	6.1 ± 0.2	6.0 ± 0.6	
		after taking	6.0 ± 0.3	5.3 ± 0.5	
Rod neutrophils,%	1.0-6.0	before admission	2.0 ± 0.2	1.2 ± 0.2	**p <0.05**
		after taking	2.0 ± 0.3	1.0 ± 0.0	**p <0.05**
Segmented neutrophils,%	47-72	before admission	48.9 ± 1.8	59.0 ± 3.2	**p <0.05**
		after taking	50.4 ± 4.2	52.7 ± 1.9	
Eosinophils,%	0-5	before admission	2.8 ± 0.4	2.5 ± 0.4	
		after taking	1.1 ± 0.3	2.2 ± 1.1	
			p <0.05		
Basophils,%	0-1	before admission	1.0 ± 0.0	0.7 ± 0.2	
		after taking	0.4 ± 0.1	0.3 ± 0.2	
			p <0.05		
Lymphocytes,%	19-37	before admission	40.5 ± 1.9	32.3 ± 3.0	**p <0.05**
		after taking	35.1 ± 1.6	37.5 ± 1.0	
			p <0.05		
Monocytes,%	2.0-10.0	before admission	4.8 ± 0.3	4.3 ± 0.2	
		after taking	7.0 ± 0.5	6.3 ± 0.6	
			p <0.05	**p <0.05**	
ESR, mm / hour	2.0-10.0	before admission	4.1 ± 0.4	3.7 ± 0.4	
		after taking	5.4 ± 1.2	4.8 ± 1.9	
Platelets, 10 · E9 / l	140-440	before admission	258 ± 15	255 ± 25	
		after taking	277 ± 18	220 ± 27	
Biochemistry					
Glucose, mmol / l	3.5-6	before admission	4.1 ± 0.1	4.8 ± 0.2	**p <0.05**
		after taking	3.8 ± 0.1	4.1 ± 0.1	
				p <0.05	
Total bilirubin, μmol / l	0-20.5	before admission	16.1 ± 2.5	12.2 ± 3.2	
		after taking	28.2 ± 9.2	14.8 ± 2.9	
Cholesterol, mmol / l	3.9-6.5	before admission	4.3 ± 0.1	3.6 ± 0.2	**p <0.05**
		after taking	4.2 ± 0.1	3.7 ± 0.2	**p <0.05**
Total protein, g / l	63-85	before admission	80.2 ± 1.1	77.3 ± 1.4	
		after taking	80.3 ± 1.5	78.7 ± 1.3	
Albumin, g / l	35-53	before admission	47.1 ± 0.6	47.0 ± 0.7	
		after taking	46.7 ± 0.6	46.8 ± 0.8	

Globulin, g / l	20-40	before admission	33.1 ± 1.1	30.3 ± 1.5	
		after taking	33.6 ± 1.3	31.8 ± 0.9	
Uric acid, μmol / l	200-416	before admission	374 ± 22	316 ± 27	
		after taking	370 ± 30	350 ± 25	
Urea, mmol / l	2.5-8.5	before admission	5.5 ± 0.2	5.3 ± 0.6	
		after taking	6.2 ± 0.4	6.2 ± 0.5	
Potassium, mmol / l	3.8-5.3	before admission	4.4 ± 0.1	4.8 ± 0.2	**$p < 0.05$**
		after taking	4.3 ± 0.1	4.3 ± 0.2	
Sodium, mmol / l	135-152	before admission	139 ± 1	140 ± 3	
		after taking	141 ± 1	136 ± 2	
Chlorides, mmol / l	98-107	before admission	102.6 ± 0.1	102.1 ± 0.5	
		after taking	101.5 ± 0.3	102.0 ± 0.6	
			$p < 0.05$		
Calcium, mmol / l	2.1-2.6	before admission	2.5 ± 0.0	2.5 ± 0.0	
		after taking	2.5 ± 0.1	2.6 ± 0.1	
Magnesium, mmol / l	0.7-1.15	before admission	1.1 ± 0.0	1.1 ± 0.0	
		after taking	1.0 ± 0.1	1.1 ± 0.1	
α-amylase, mU / l	0-200	before admission	179 ± 18	182 ± 35	
		after taking	173 ± 19	183 ± 33	
Amylase pancreatic, U / l	17-115	before admission	70.2 ± 6.5	72.7 ± 14.1	
		after taking	69.0 ± 7.6	73.3 ± 13.1	
Lipase, U / l	0-160	before admission	70.7 ± 6.0	80.2 ± 7.7	
		after taking	71.1 ± 3.9	73.5 ± 7.3	
Rheumatoid factor, honey / l	0-20	before admission	11.4 ± 0.4	11.9 ± 0.7	
		after taking	12.5 ± 0.5	14.3 ± 0.3	**$p < 0.05$**
				$p < 0.05$	
Immunology					
Ig-G, g / l	8.0-17.0	before admission	12.4 ± 0.4	12.6 ± 0.4	
		after taking	10.9 ± 0.7	10.7 ± 1.1	
Superoxide dismutase in erythrocytes, E / gmol	1100-1800	before admission	1415 ± 60	1298 ± 56	
		after taking	1474 ± 43	1459 ± 73	
Antioxidant activity,%	3.9-6.5	before admission	49.4 ± 2.5	42.7 ± 2.8	
		after taking	53.2 ± 2.9	48.5 ± 3.0	
Diagnosis of anemias					
Folic acid, ng / ml	3.0-17.0	before admission	7.7 ± 0.6	8.7 ± 0.8	
		after taking	7.9 ± 0.7	6.8 ± 0.4	
Erythropoietin, IU / ml	2.6-34	before admission	7.5 ± 0.6	6.4 ± 0.6	
		before admission	8.0 ± 1.3	5.8 ± 1.3	
D oormonal analysis					
T3, ng / ml	0.8-2.0	after taking	1.5 ± 0.1	1.3 ± 0.1	
		before admission	1.2 ± 0.1	1.4 ± 0.1	
			$p < 0.05$		
TSH, μmE / ml	0.4-4.0	before admission	2.5 ± 0.3	2.5 ± 0.4	
		after taking	1.4 ± 0.2	2.5 ± 0.7	
			$p < 0.05$		
Prolactin, IU / L	53.0-360.0	before admission	256 ± 46	289 ± 103	
		after taking	290 ± 69	290 ± 110	
Total testosterone, nmol / l	9.0-57.6	before admission	21.0 ± 2.8	23.0 ± 1.7	
		after taking	21.7 ± 3.1	23.9 ± 2.3	
Cortisol	138-690	before admission	646 ± 44	623 ± 92	
		after taking	584 ± 38	655 ± 78	
Insulin, IU / ml	6.0-27.0	before admission	5.3 ± 0.8	4.0 ± 0.9	
		after taking	8.0 ± 0.7	7.2 ± 0.3	
			$p < 0.05$	**$p < 0.05$**	

From the data given in the table it can be seen that almost all of the examined blood parameters were initially in the normal range, with the exception of the level of erythrocytes and the level of lymphocytes in persons of the "Light water" group. The initially high level of red blood cells in athletes is due to the fact that all of them regularly go in for sports, and, therefore, are exposed to intense physical activity. Intense physical activity requires the consumption of large volumes of oxygen, carriers which in the human body are exactly red blood cells. It is not difficult to understand why long-term sports activities lead to persistent erythrocytosis in the blood of athletes.

"28-day" course intake of "light water" caused a number of changes in the blood of the subjects of the "Light water" group. Compared with the baseline, they showed a significant decrease in the level of eosinophils ($p < 0.05$), a significant decrease in basophils ($p < 0.05$), a significant decrease in the initially high level of lymphocytes ($p < 0.05$) and a significant increase in the level of monocytes in blood ($p < 0.05$). Besides in addition, there was a significant decrease in chlorides ($p < 0.05$), hormones T3 ($p < 0.05$) and TSH ($p < 0.05$), a marked increase in insulin in the blood ($p < 0.05$). Tendencies towards a decrease in the level of glucose and erythrocytes in the blood were noted, which ultimately led to a tendency towards an increase in bilirubin.

In the control group ("Control water"), significant changes were also noted: a significant increase in monocytes in the blood ($p < 0.05$), a significant increase in insulin ($p < 0.05$) and a significant decrease in blood glucose ($p < 0.05$) , significant increase in rheumatoid factor ($p < 0.05$). Drinking plain water did not contribute to a decrease in the initially elevated level of erythrocytes (the level of erythrocytes did not change), and, therefore, an increase in the level of bilirubin in the blood was not observed. As in the "Light water" group, they also showed a tendency to a decrease in the level of eosinophils and basophils, however, in contrast to the "Light water" group, the level of lymphocytes in their blood had a weak tendency to increase.

Analyzing the above, it should be noted that intense physical activity leads to the development of fatigue processes in the athlete's body. With fatigue, the level of leukocytes and lymphocytes in the blood rises, the levels of neutrophils, eosinophils and basophils decrease, the level of insulin and testosterone decreases, and the level of cortisol in the blood rises [13]. but "Light water" (deuterium-free, achloride water) had a positive effect on the functional state of the subjects, since it contributed to a significant decrease in initially high the level of red blood cells in the blood, probably due to the activation of the process of their destruction in the liver. This is evidenced by the trend towards a pronounced raising bilirubin in the blood. In addition, the intake of "light water" contributed to normalization of the level of lymphocytes in the blood and a tendency to an increase in the initially low level of insulin. At the same time, the blood glucose level had a weak tendency to decrease, remaining in the normal range. The manifested tendency to an increase in testosterone in the blood can be regarded as a harbinger of an increase in physical performance. There is a tendency towards decrease in leukocytes and cortisol in the blood, there was a tendency to increase superoxide dismutase (SODM) and indicator general antioxidant activity (AOA), which can be considered as the anti-stress protective effect of "light water". There was also a significant decrease in chlorides in the blood of the examinees of the "Light Water" group, which cannot be said about those who drank ordinary water. Therefore, the intake by athletes additional volumes of "light water" in the process of intense training is a means of preventing dehydration and maintaining the input-salt balance. This is objectively reflected in the maintenance of the level of total protein and blood hematocrit. In addition, the intake of additional volumes of liquid against the background of physical activity has a beneficial effect on the state of the liquid media of athletes, however, if the liquid is "light water", then it makes these effects even more pronounced.

Summarizing what has been said, it should be noted that *presented dynamics indicators indicate a positive effect of "light water" on the functional state highly qualified athletes and allows to consider "light water" as a means of restoring blood parameters, vegetative balance and blood circulation parameters during intense physical exertion.*

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