The influence of rhodiola rosea and controlled self-regulation of the state of the immune system during the mental workload and exercise work stress

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Abstract. The study of the combined influence of the medication of rhodiola rosea and methods of controlled self-regulation on the indices of immune system while modelling the workload of mental and exercise stress of unexercised people. Within the framework of the investigation 120 students of Semipalatinsk State Medical University of Semey City were tested. The exercise load stress was modelled using the original methodology, the mental workload was modelled by means of implementation of "Skimming technique" method during which the students were taught 5 days a week by the procedure of O.A. Andreev and L.N. Khromov. Rhodiola rosea sereved as adaptogen, the method of controlled self-regulation was applied. There were detected the derangement of immune indices by people who were undergone high physical and mental stress as well as the tendency to their correction while using rhodiola rosea on the background of controlled self-regulation.
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Introduction

Today not only trendy talks about immunity are popular but also various programs and means of its reinforcement. The formation of health level of every individual depends on a variety of factors, including: hereditary, environmental, and behavioural [1,2]. Physical exercises invoke a complex of physiological and biochemical changes in the organism, among which immunologic responsiveness shifts, are leading ones [3]. Recent studies in the sphere of immunology showed that the immune system is responsible not only for the determination of stability to infectious agents but it also provides the immunological surveillance for maintaining inner homeostasis. Under the conditions of systematic influence of physical factors it is the immune system that takes place first of all in formation of adaptive reactions as a response to these influences [4]. In case of immune homeostasis disorder the sum of exercise loads can result inovertraining, overstrain which, in its turn, prompts the development of pre-pathological states, decrease of the resistance of the body to the inner and outer environmental factors influence [5].

Today in order to correct stress-induced disorders the following groups of pharmaceutical medications are commonly used: adaptogens and vitamin products, antidepressant medications, antipsychotics, psychostimulants and isotrops, curantyl [6, 7]. That's why the scientists' attention is recently paid to the non-traditional, alternative methods of stress-reactions correction using natural compounds [8]. From the viewpoint of stress development mechanisms the use of adaptogens is reasonable [9].

To raise the effectiveness of human activity under the modern conditions it is necessary not only to create stimulating social-economic relationships, but also to implement measures aimed at increase of human adaptive capabilities. One of the prospective directions of this sphere is the use of methods of self-regulation which develop the human's ability of aware regulation of his/her functional state [10].

Goal of investigation: The study of the combined influence of the medication of rhodiola rosea and methods of controlled self-regulation on the indices of immune system while modelling the workload of mental and exercise stress of unexercised people.

Materials and methods of investigation. Within the framework of the investigation 120 volunteers of Semipalatinsk State Medical University of Semey City were tested (The study protocol was approved by the Local Ethics Committee of the Semey State Medical University, Semey, Kazakhstan with the number of No3 dated October, 2013.). At the moment of investigation the age of people under investigation was from 18 to 22 (average age 19.0±0.1year). All the examined volunteers were of the completely healthy people group at the moment of investigation, i.e. they had no chronic inflammatory and infectious diseases as well as acute states accompanied by the temperature rise or acute

changes of hemodynamic parameters (increase or decline in adaptive skills). Modelling of exercise load stress was performed by means of cycle ergometer test with the help of veloergometer VEM-70. The level of physical exertion that comply with submaximal cardiac rate (180 strikes per minute for the given age category) was taken as the initial. Further the pedalling was continued upon the increased load for 1 stage (25 W) until a person under investigation refuses to continue due to the impossibility of load accomplishment. After the rest the test was repeated three times during 1 hour. The mental workload was modelled by means of implementation of "Skimming technique" method during which the students were taught 5 days a week by the procedure of O.A. Andreev and L.N.Khromov. Rhodiola rosea sereved as adaptogen, the method of controlled self-regulation was applied.

Results

There were no significant differences from the group without correction by the indices of lymphocytes, common T-lymphocytes, B-lymphocytes count (except the absolute cell count of the given type in 24 hours, which exceeded 18.4%, p<0,05), CD4 count (Table 1). At the same time the decrease of CD8 count was prevented by use of combination of rhodiola rosea and method of controlled self-regulation. Significant differences towards the increase were registered at their relative count in 3, 6, 24 and 48 hours (for 19.7%, 37.5%, 51.0% and 48.6% respectively, p<0,05 for all cases).

The similar differences on absolute count were detected for all the terms of investigation including the initial period when their amount was 32.1% (p<0,05) in 3 hours it was moderately decreasing (to 25.9%, p<0,05), and then was increasing again up to 33.3% - in 6 hours (p<0,05), 52.2% (p<0,05) - in 24 hours, 57.1% (p<0,05) - in 48 hours when the differences for this index reached their maximum. In the course of the following investigations they decreased and amounted to 29.2% (p<0,05)- in 72 and 20.0% (p<0,05)- in 120 hours.

The ratio of CD4+ and CD8+ count were significantly lower than the index of the group without correction on the initial period and further, starting from 6 hours and up to the final date of investigation. However, in 6 hours the differences were 24.2% (p<0,05), in 24 hours - 36,2% (p<0,01), in 48 hours -37,6% (p<0,05), in 72 hours - 24,1% (p<0,05)and in 120 hours - 19,2% (p<0,05).

Relative count of autorosette-forming cells in blood were, on the contrary, lower during the initial period of the investigation (22.9%, p<0,05). Further - in 6 hours - they amounted to 22.7%, in 24 hours - 23.9%, in 48 hours - 20.0%, in 72 hours - 20.5% and in 120 hours - 29.1% (p<0,05 for all mentioned times).

For the absolute count of autorosette-forming cells the significant differences were registered in 6, 24 and 120 hours - towards decrease with regard to the control (for 25.0%, 23.3% and 21.7% respectively, p<0,05 for all cases). The average indices of count of main classes of immunoglobulin in blood had no significant differences with the group of comparison, though at the beginning of the experiment there were tracked a slight exceed of IgM.● concentration.

Table 1. The dynamics of some immune system indices, subjected to the high mental workload by the use of rhodiola rosea and methods of controlled self-regulation.

Index	Term of examination													
	result		3 hours		6 hours		24 hours		48 hours		72 hours		120 hours	
	without correction	combined correction	without correction	combined correction	without correction	combined correction	without correction	combined correction	without correction	combined correction	without correction	combined correction	without correction	combined correction
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Lymphocytes, *10^9/l	2.34±0.14	2.58±0.14	2.51±0.17	2.64±0.17	2.66±0.16	2.58±0.15	2.49±0.18	2.51±0.17	2.43±0.14	2.57±0.14	2.38±0.18	2.62±0.19	2.31±0.17	2.55±0.17
T-Lymphocytes, %	59.8±3.5	60.5±3.4	60.2±4.0	59.8±3.8	62.8±3.8	62.8±3.6	63.9±4.6	64.9±4.4	60.5±3.4	62.3±3.3	60.5±4.7	59.9±4.4	60.2±4.3	60.4±4.1
B-Lymphocytes, %	23.5±1.2	23.3±1.2	20.7±1.2	21.2±1.2	19.2±1.3	21.3±1.4	19.7±1.2	23.1±1.3	21.8±1.6	23.7±1.6	23.5±1.3	22.9±1.2	25.1±1.9	24.3±1.8
CD4+, %	40.6±2.1	39.1±2.0	37.5±2.2	36.7±2.1	36.8±2.5	38.4±2.4	42.2±2.6	40.6±2.3	44.0±3.1	40.9±2.8	43.3±2.4	38.5±2.0	42.9±3.3	37.6±2.8
CD8+, %	12.0±0.7	14.3±0.8*	10.8±0.6	12.9±0.6*	9.0±0.5	12.4±0.7*	9.2±0.6	13.9±0.9*	8.6±0.5	12.8±0.7*	10.1±0.7	11.8±0.8	10.8±0.6	11.7±0.6
CD4+/CD8+	3.39±0.19	2.73±0.14*	3.48±0.25	2.85±0.19	4.08±0.21	3.09±0.16*	4.57±0.27	2.91±0.16*	5.10±0.34	3.18±0.20*	4.29±0.26	3.26±0.19*	3.96±0.28	3.20±0.22*
Autorosette-forming cells, %	8.5±0.5	6.6±0.3*	9.2±0.7	7.6±0.5	10.5±0.6	8.1±0.4*	12.0±0.7	9.2±0.5*	10.7±0.7	8.6±0.5*	10.1±0.6	8.0±0.5*	10.0±0.7	7.1±0.5*
IgA, g/l	1.47±0.11	1.51±0.11	1.43±0.08	1.50±0.08	1.45±0.10	1.47±0.10	1.48±0.08	1.50±0.08	1.51±0.09	1.49±0.08	1.56±0.10	1.48±0.09	1.53±0.09	1.50±0.09
IgM, g/l	1.12±0.09	1.33±0.10	1.07±0.06	1.27±0.07*	1.09±0.08	1.22±0.08	1.05±0.06	1.21±0.06	1.14±0.07	1.24±0.07	1.17±0.08	1.27±0.08	1.17±0.07	1.30±0.08
Circulating immune complexes, standard unit	4.85±0.35	3.87±0.26*	4.79±0.37	4.03±0.30	5.12±0.28	4.51±0.24	5.36±0.32	4.47±0.26*	5.49±0.29	4.32±0.22*	5.76±0.34	4.80±0.27*	5.14±0.34	4.12±0.26*
Note - "- differences with indices of the group without correction are significant, p<0,05														

In the group of combined correction there was registered significantly lower level of Circulating immune complex during the examination in the initial period of the experiment (20.2% lower, p<0,05). Further this index in the main group also remained lower that in the group of comparison, but the differences again became significant in 24 hours (16.6%, p<0,05) and remained such until the final examination (21.3%, p<0,05 - in 48 hours and 19.8%, p<0,05 - in 120 hours).

Number of phagocytosed cells at the outcome of experiment was relatively decreased, inversion of this index took place in 24 hours. People under investigation of the main group had significantly higher phagocytosed cells number, that those of the group of comparison during the whole course of the experiment. Differences between groups concerning the index of phagocytic segment

of the immune system were not significant. As well as in the group of high mental workload, there were detected no significant differences between groups concerning the indices of lymphocytes and T-lymphocytes count during the stress of high exercise load (Table 2). Relative count of B-lymphocytes were higher in time if 24 and 48 hours (41.2%, p<0,05 and 34.4%, p<0.05 respectively), absolute - from 24 - to 72 hours (33.3%, 31.0% and 24.3% higher respectively, p<0.05 for all terms). CD4+ count were lower in the second half of the experiment, significant differences for relative count were registered in 72 hours (22.0%, p<0.05) in spite of the fact that there were no significant differences detected for absolute index. Relative count ofCD8+ was significantly lower in 6 hours (17.5% lower, p<0.05), absolute count of cells of the differential cluster had no significant differences with the group of correction. The ratio CD4+/CD8+ increased in 6 hours (27.7% higher, p<0.05) and this index lowered in 48 and 72 hours for 19.4% and 27.4% respectively (p<0.05 for the first case and p<0.01 for the second case) in contrast with the group of comparison. In all cases of correction the peak values of the dynamics of the last index were neutralized (Figure 1).

Autorosette-forming cells count by the relative level of the index was significantly lowered in the group of combined correction in relation to the group of comparison in the result (24.4% lower, p<0,05), in 6, 24, 48 and 72 hours (21.4%, 28.4%, 33.4% and 39.5% - p<0.05, p<0,05, p<0.05 and p<0,01 respectively). Absolute values of this index were significantly lower also at the beginning, besides, in 6 hours (22.2% lower), in 24 hours (32.4% lower), in 48 hours (35.1% lower) and in 72 hours (34.3% lower) (p<0,05for all the cases).

Immunoglobulin count was higher in the group of correction in relation to the group of comparison almost in all terms of investigation. However, these differences were significant only by the IgM count and only in 24 hours after the modelling of stress (20.2% higher, p<0,05).

Content of circulating immune complexes was, on the contrary, lower. Significant differences by this index were registered in 6 hours (19.9%,p<0,05), in 24 hours (39.1%, p<0,01), in 48 hours and 72 hours (34.0% and 24.6%, p<0,05). Thus, the use of this method to the fullest extent provided the prevention of increase of circulating immune complexes content in the result of stress influence and potential development of immunocomplex abnormality.

Table 2. The dynamics of some immune system indices, subjected to the stress of exercise load by the use of the combination of rhodiola rosea and methods of controlled self-regulation.

Index	Term of examination													
	result		3 hours		6 hours		24 hours		48 hours		72 hours		120 hours	
	without correction	combined correction	without correction	combined correction	without correction	combined correction	without correction	combined correction	without correction	combined correction	without correction	combined correction	without - correction	combined correction
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Lymphocytes, *10^9/l	2.27± 0.13	2.53± 0.12	2.65± 0.18	2.68± 0.15	2.75± 0.17	2.70± 0.14	2.88± 0.22	2.72± 0.17	2.76± 0.15	2.69± 0.12	2.44± 0.19	2.65± 0.17	2.30± 0.16	2.57± 0.15
T-Lymphocytes, %	60.8± 3.0	58.9± 2.7	57.0± 4.4	57.8± 4.0	56.4± 3.4	59.6± 3.3	54.5± 4.19	59.9± 4.2	54.0± 3.0	59.5± 3.0	55.7± 4.3	59.6± 4.2	56.1± 4.0	59.9± 3.9
B-Lymphocytes, %	23.3± 1.2	22.5± 1.0	17.7± 1.4	20.5± 1.4	16.5± 1.1	18.9± 1.1	13.5± 1.0	19.1± 1.3*	15.2± 1.1	20.4± 1.3*	19.3± 1.1	21.9± 1.1	22.2± 1.7	21.8± 1.5
CD4+, %	40.5± 2.0	39.5± 1.6	33.2± 2.6	36.2± 2.3	34.8± 2.3	36.7± 2.0	39.2± 3.0	38.2± 2.5	45.3± 3.2	40.1± 2.4	50.8± 2.8	39.6± 1.8*	43.9± 3.4	38.1± 2.4
CD8+, %	11.9± 0.6	11.1± 0.5	12.1± 0.9	11.2± 0.8	13.9± 0.8	11.5± 0.6*	10.8± 0.83	12.1± 0.8	10.1± 0.6	11.2± 0.6	9.8± 0.7	10.6± 0.7	11.7± 0.7	10.9± 0.6
CD4+/ CD8+	3.41± 0.17	3.57± 0.16	2.75± 0.20	3.23± 0.20	2.50± 0.13	3.19± 0.15*	3.65± 0.28	3.15± 0.21	4.46± 0.31	3.60± 0.22*	5.17± 0.31	3.75± 0.20*	3.74± 0.27	3.50± 0.22
Autorosette-forming cells, %	8.4± 0.4	6.3± 0.3*	7.9± 0.6	6.7± 0.5	9.9± 0.5	7.8± 0.4*	11.8± 0.9	8.5± 0.6*	13.4± 0.9	8.9± 0.6*	14.3± 0.9	8.7± 0.5**	9.6± 0.7	9.7± 0.7
IgA, g/l	1.41± 0.07	1.47± 0.07	1.39± 0.08	1.45± 0.07	1.31± 0.09	1.39± 0.09	1.19± 0.06	1.35± 0.06	1.25± 0.09	1.36± 0.09	1.40± 0.09	1.44± 0.09	1.48± 0.09	1.45± 0.08
IgM, g/l	1.17± 0.06	1.25± 0.06	1.23± 0.07	1.29± 0.07	1.00± 0.07	1.21± 0.09	1.04± 0.05	1.25± 0.07*	1.20± 0.08	1.27± 0.09	1.29± 0.09	1.31± 0.09	1.22± 0.07	1.30± 0.08
Circulating immune complex, standard unit	4.59± 0.33	4.17± 0.30	4.72± 0.36	4.55± 0.35	6.28± 0.35	5.03± 0.28*	10.03 ± 0.61	6.11± 0.37**	9.47± 0.65	6.25± 0.43*	7.16± 0.42	5.40± 0.32*	5.22± 0.35	4.81± 0.32

Note - *- differences with indices of the group without correction are significant, p<0,05

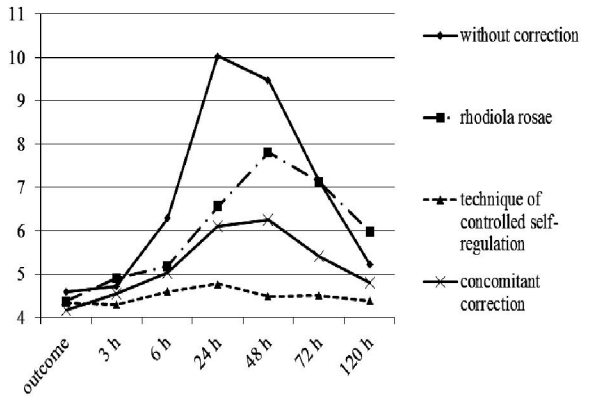
Along horizontal axis: time in hours; along vertical axis: % of CD4+/CD8+ count

Figure 1 gives the average indices of CD4+/CD8+ ratio in dynamics of people under investigation while having stress of exercise load (Figure 1 is not shown in this paper).

As one can see from Figure 2, the most significant decrease of circulating immune complexes in the condition of the stress of exercise load was detected while using the method of controlled self-regulation. In this case there was observed the absence of both early activation and increase in 48 hours after stress modelling which is characteristic for the group of rhodiola rosae.

At the end of the investigation the number of phagocytosed cells was insignificantly higher in group of correction than in the group of comparison. However in 6 hours after modelling of stress it became 10% lower than in the condition of correction absence, and in 24 hours the differences were significant (25.3%, p<0,05), and till the end of the investigation the per cent of phagocytosed cells was lower, though insignificant, in the main group than in the group of comparison. This fact as well as absence of the increase of phagocytosed cells number which is characteristic for the group of comparison (significant differences in 24 hours - 17.6% and in 48 hours - 19.3%)is an indirect proof in favour of the fact that the prevention of increase of circulating immune complexes content in blood while using the method of correction took place due to the prevention

of their formation but not to the1 decrease of their elimination.



Along horizontal axis: time in hours; along vertical axis: Content of circulating immune complexes in blood (standard unit)

Figure 2. Specific features of dynamics of circulating immune complexes content in the blood of people under investigation in the dynamics of stress of exercise load depending on the current correction

As to the nosogenesis of immune abnormality, this fact is very important as it prevents the damage of the vessel wall and tissues for the account of activation of immune mechanisms.

Conclusion

Thus, the acquired data speak for the high effectiveness concerning the correction of immune indices disorder on the background of stress of high exercise load and mental workload while complex using of rhodiola rosea and method of controlled self-regulation.

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