J Biochem Technol (2022) 13(1): 7-12
https://doi.org/10.51847/NoIozXVK5j
ISSN: 0974-2328

Hematological Indicators of Students Who Started Races

Ekaterina Sergeevna Kachenkova, Yulia Vladimirovna Zbrueva, Elena Sergeevna Tkacheva*, Dmitry Mikhailovich Pravdov, Maxim Viktorovich Eremin, Angela Valeryevna Romanova, Victor Ivanovich Sharagin, Elmira Shamilevna Petina, Alexander Leonidovich Yurchenko

Received: 06 November 2021 / Received in revised form: 17 February 2022, Accepted: 20 February 2022, Published online: 02 March 2022

Abstract

A prominent place among the hematological parameters is occupied by the parameters of erythrocytes. They affect the processes of microcirculation, gas exchange, and metabolism. In this regard, it is of great interest to study changes in erythrocyte parameters in students who previously had low physical activity and started regular sports walking. The study was conducted on 39 young university students who had not previously played sports and experienced low physical activity during their lives. All of them started regular race-walking workouts 4 times during the week. The control group consisted of 35 young male students who, for at least 4 years, systematically engaged in race walking at least 4 times a week. For the study, standard hematological, biochemical, and statistical methods of obtaining information were used. After 6 months of sports walking in the blood of previously low-trained young men, there was a normalization of the levels of arachidonic acid derivatives, a decrease in the content of cholesterol, and lipid peroxidation products in the membranes of erythrocytes, and an increase in the content of phospholipids in them. This was accompanied by an increase in the number of erythrocytes with a normal shape in the blood of those who began to engage in race walking and a decrease in the content of erythrocytes with a changed shape in it. The beginning of race walking after low physical activity is very useful in adolescence for the parameters that are significant for the implementation of blood circulation in the capillaries.

Keywords: Students, Race walking, Muscle loads, Erythrocytes, Microrheological properties

Ekaterina Sergeevna Kachenkova
Institute of Natural Science and Sports Technologies of the Moscow City Pedagogical University, 129226, Moscow, Russia.

Yulia Vladimirovna Zbrueva
Department of Forensic Medicine, FSBE "Astrakhan State Medical University", 414000, Astrakhan, Russia.

Elena Sergeevna Tkacheva*
Department of Epizootiology and Microbiology, Vologda State Dairy Farming Academy named after N.V. Vereshchagin, 160555, Vologda, Russia.

Dmitry Mikhailovich Pravdov, Maxim Viktorovich Eremin
Faculty of Physical Education, Russian State Social University, 129226, Moscow, Russia.

Angela Valeryevna Romanova
Psychology faculty, Russian State Social University, 129226, Moscow, Russia.

Victor Ivanovich Sharagin
Department of Physical Education and Fundamentals of Life Safety, Moscow State University of Psychology and Education, 115432, Moscow, Russia.

Elmira Shamilevna Petina
Department of Physical Education, Astrakhan State Medical University, 414000, Astrakhan, Russia.

Alexander Leonidovich Yurchenko
Department of Physical Education, Financial University under the Government of the Russian Federation, 125993, Moscow, Russia.

***E-mail:** ilmedv1@yandex.ru

Introduction

For modern youth, a low level of physical fitness is very characteristic, leading to weak development of the muscular system (Khitrov & Paukov, 1991; Medvedev & Zavalishina, 2016). The emerging situation in the body of poorly trained young people contributes to the accelerated formation of pathologies based on the existing hereditary predisposition to many diseases (Amelina & Medvedev, 2009; Bespalov *et al*., 2018a). A great danger to the health of low physical activity was noted in different categories of subjects of different ages (Mal *et al*., 2018a; Glagoleva & Medvedev, 2020; Halimah *et al*., 2022). In conditions of low physical activity, even in young years, the functional indicators of all internal organs deteriorate, the threat of the development of pathology increases, and the frequency of occurrence of various diseases increases (Medvedev, 2018c; Karpov *et al*., 2020a). The presence of prolonged physical inactivity also contributes to the aggravation of the course of any existing diseases, stimulating the appearance of their various complications (Bespalov *et al*., 2018b; Makhov & Medvedev, 2018a).

Very quickly, weak muscle activity begins to adversely affect various blood parameters (Azhar *et al*., 2019; Moubarez *et al*., 2019; Glamazdin *et al*., 2021; Shaheen *et al*., 2022). This leads to several biologically very unfavorable changes in the body (Dembo & Zemtsovsky, 1989; Medvedev & Skoryatina, 2014). A low level of physical fitness leads to the development of microrheological

disorders of the blood with signs of gradually increasing hypoxia in the organs (Skoryatina & Medvedev, 2019). Chronic oxygen deficiency formed under these conditions inhibits anabolic mechanisms in all organ systems (Mal *et al*., 2020). The resulting conditions favor the formation of pronounced vasospasm and disrupt the function of all cells in the body (Medvedev, 2018g; Medvedev *et al*., 2021). It has been noticed that with prolonged maintenance of low physical activity, conditions are formed that lead to an increase in the level of blood pressure and the development of further arterial hypertension (Skoryatina & Zavalishina, 2017; Zavalishina *et al*., 2021c). In addition, during hypodynamia, the basic rheological properties of all groups of blood corpuscles and especially erythrocytes deteriorate. These disorders can occur already in youth and contribute to the development of many pathological conditions (Vorobyeva *et al*., 2018; Karpov *et al*., 2020b; Aldhairyan *et al*., 2022). Due to the negative effect of weak muscle activity on the functioning of the body, especially among students during their studies at the university, it is necessary to continue to actively search for options for its elimination in them, taking into account the dynamics of hematological parameters and especially the parameters of erythrocytes.

The objective of the performed observation: to determine the dynamics of hematological changes in young men who started regular sports walking after a long period of low physical activity.

Materials and Methods

The study was carried out with the involvement of 39 male university students (average age 18.9±1.0 years) who did not experience systematic muscular loads throughout their lives. All of them started regular race walking at least 4 times a week. The duration of classes per day was at least 1 hour. The control group consisted of 35 healthy university male students (mean age 19.1±1.2 years). These young men regularly practiced race walking for at least 4 years at least 4 times a week. The duration of each lesson for them was equal to at least 1 hour a day.

The amount of thromboxane B_2 and the level of 6-keto-prostaglandin $F_{1\alpha}$ were determined in the blood of those taken under observation employing an enzyme-linked immunosorbent assay using a set of reagents manufactured by EnzoLifescience (USA). In the composition of erythrocyte membranes, after the procedure for washing erythrocytes and their resuspension, the cholesterol content was determined by the enzymatic colorimetric method using a set of reagents manufactured by Vital Diagnosticum (Russia). Also, in the membranes of erythrocytes, the number of total phospholipids was found out by the amount of phosphorus in them. The severity of lipid peroxidation inside erythrocytes was determined after the procedure of washing and resuspension of erythrocytes by assessing the content of malondialdehyde in them and the concentration of acyl hydroperoxides using standard methods.

The number in the blood of the examined discoid erythrocytes and their altered forms was determined by light phase-contrast microscopy using standard technology.

The observation group was examined at baseline and after 3 and 6 months of regular physical activity. The control group was examined once - at the time of the start of the study.

Statistical processing of the results obtained in the study was carried out using the Student's t-test.

Results and Discussion

In the blood of young men who had previously had low physical fitness, non-physiological changes in the levels of substances synthesized from arachidonic acid were initially revealed **(Table 1)**. The content of thromboxane B_2 was higher than the level in the control group by 27.3% ($p<0.01$), while the content of 6-keto-prostaglandin $F_{1\alpha}$ in the subjects was 15.1% lower than the control level.

When taken into the study in the erythrocyte membranes of young men who made up the observation group, the amount of cholesterol was higher than the control level by 17.6%, while the level of total phospholipids in them was initially lower than the control values by 13.4%. In the blood of young men who had low physical fitness in the end, the content of acyl hydroperoxides and malonic dialdehyde was higher than in the students who made up the control group by 41.8% ($p <0.01$) and 40.3% ($p <0.01$), respectively.

Table 1. The indicators are taken into account in the surveyed during the observation

Blood indicators	Started training, n=39, M±m			Control, n=35, M±m
	start of research	3 months of research	6 months of research	
Thromboxane B_2, pg/ml	183.4±0.69 $p<0.01$	163.6±0.78 $p<0.05$	142.7±0.65 $p_1<0.01$	144.1±0.71
6-keto prostaglandin F1α, pg/ml	85.6±0.38 $p<0.01$	92.0±0.41 $p<0.05$	98.7±0.29 $p_1<0.05$	98.5±0.38
Erythrocyte cholesterol, μmol /10^{12} erythrocytes	1.03±0.012 $p<0.01$	0.95±0.014 $p<0.05$	0.88±0.009 $p_1<0.05$	0.88±0.018
Total phospholipids of erythrocytes, μmol/10^{12} erythrocytes	0.67±0.005 $p<0.01$	0.71±0.010 $p<0.05$	0.76±0.008 $p_1<0.05$	0.76±0.006

Discoid erythrocytes, %	79.2±0.33 p<0.01	84.6±0.27 p<0.05	89.8±0.36 p_1<0.05	89.9±0.26
Reversibly altered red blood cells, %	11.8±0.15 p<0.01	10.6±0.14 p<0.01 p_1<0.05	9.2±0.11 p_1<0.01	9.1±0.69
Irreversibly altered erythrocytes, %	9.0±0.16 p<0.01	4.8±0.12 p<0.01 p_1<0.05	1.0±0.06 p_1<0.01	1.0±0.08
Acylhydroperoxide of erythrocytes, $D_{233}/10^{12}$ erythrocytes	3.90±0.012 p<0.01	3.38±0.017 p<0.01	2.80±0.019 p_1<0.01	2.75±0.010
Malonic dialdehyde of erythrocytes, nmol/10^{12} erythrocytes	1.81±0.005 p<0.01	1.54±0.010 p<0.05	1.30±0.016 p_1<0.01	1.29±0.012

Note: p - reliability of differences in indicators in the control group and the observation group; p_1 - reliability of the dynamics of the recorded indicators in the observation group during the study.

When young men with poor physical fitness were taken into the study, a 13.5% decrease in the number of discoid erythrocytes was recorded **(Table 1)**. In their blood, the levels of reversibly and irreversibly altered erythrocytes were higher than in the control group by 29.7% and 9.0 times, respectively (p<0.01).

As a result of the beginning of regular sports walking in young men who made up the observation group, the severity of the imbalance of substances synthesized from arachidonic acid decreased. By the end of the observation in their blood, the concentration of thromboxane B_2 decreased by 28.5% (p<0.01). At the same time, by the end of the study, the content of 6-keto-prostaglandin $F_{1\alpha}$ in their blood increased by 15.3% and reached the control level (p<0.05).

In the erythrocyte membranes of young men included in the observation group in the course of systematic sports walking, by the end of the observation, a decrease in cholesterol content developed by 17.6%. This was accompanied by an increase in the number of total phospholipids in their erythrocytes by 13.4% (p<0.05). The changes that occurred in young men who had gone to regular physical activity were accompanied by a decrease in erythrocytes during the observation period of the concentration of acyl hydroperoxides by 39.3% (p<0.01) and a decrease in the content of malonic dialdehyde in them by 39.2% (p<0.01).

Under the conditions of regular sports walking, the content of erythrocytes having a discoid shape in the blood of young men of the observation group increased by 13.4% (p<0.05) **(Table 1)**. In the blood of those who started the physical activity, the levels of reversibly transformed erythrocytes and irreversibly changed erythrocytes decreased over the entire study period, respectively, by 28.3% (p<0.01) and 9.0 times (p<0.01).

Long-term maintenance of the main indicators of the human body at the level of optimal values is possible under conditions of systematic dosed physical activity (Medvedev, 2018e; Zavalishina *et al*., 2021b). In the case of a long period of hypodynamia, persistent pre-pathological conditions very often arise, and various pathologies develop (Glagoleva *et al*., 2018). The negative influence of weak muscle activity on hematological characteristics has a serious biological significance in this (Makhov & Medvedev, 2018c; Zavalishina, 2020; Jose *et al*., 2022; Liu *et al*., 2022).

Weak physical activity contributes to the development of disorders of microrheological parameters of blood cells and, first of all, the most numerous of them – erythrocytes (Zavalishina *et al*., 2021a). An excess of lipid peroxidation products in erythrocytes always leads to biologically unfavorable rearrangements in erythrocyte membranes, which weakens their functions (Zavalishina, 2018e). Another negative factor in conditions of reduced muscle activity is lipid imbalance in the composition of erythrocyte membranes, which has a very negative effect on the functioning of these blood cells (Medvedev, 2018f). The upcoming changes in their membranes of phospholipid content and cholesterol content are functionally very disadvantageous (Medvedev, 2018d; Zavalishina, 2018d). This disrupts the mechanisms of selective permeability that work in erythrocyte membranes, and inhibits biochemical processes in them, largely due to the development of changes in the secondary and tertiary structure of membrane proteins. The resulting changes negatively affect the functional processes in the membranes of the bulk of erythrocytes in the blood (Medvedev, 2018h; Makhov & Medvedev, 2021; Makhoahle & Gaseitsiwe, 2022).

An increase in the number of various altered reversibly erythrocytes and an increase in the level of altered erythrocytes irreversibly leads to an increase in the concentration of their aggregates in the blood of young men with low physical activity, which always impairs the processes of microcirculation (Medvedev, 2018b; Zavalishina, 2018f).

In young men with low physical fitness in the walls vessels, there was a weakening of the synthesis of substances important for hemocirculation that have disaggregation properties concerning all blood cells. Under these conditions, the growth of substances with proaggregant activity occurs in the blood of young men (Tkacheva & Zavalishina, 2018b). First of all, this is due to the developing intensification of the formation of thromboxane and inhibition of the synthesis of its functional antagonist prostacyclin. This is based on an imbalance in the blood of substances synthesized from arachidonic acid (Zavalishina, 2018g). The deterioration of the microrheological parameters of erythrocytes arising under these

conditions greatly impairs the processes of microcirculation and inhibits all types of metabolism in organs and tissues (Medvedev, 2021).

For the general health improvement of the body of young men with physical inactivity, an increase in physical activity in the form of regular sports walking was used in the work performed. Against the background of these training, the observed young men experienced a decrease in the concentration of lipid peroxidation products in their erythrocytes, which improved the functional state of their membranes (Makhov & Medvedev, 2018b; Zavalishina *et al*., 2018). Optimization of the state of the bulk of erythrocytes in those who started sports walking also occurred as a result of the positive dynamics of the lipid composition of their membranes (Tkacheva & Zavalishina, 2018a). As a result of these changes, the state of the surface characteristics of the membranes of the bulk of erythrocytes in the blood improved (Zavalishina, 2018c; Karpov *et al*., 2021b). This is because optimization of the content of phospholipids and cholesterol in erythrocyte membranes has a pronounced positive effect on their functions (Karpov *et al*., 2021a). All this leads to the optimization of many parameters of erythrocytes, especially the stability and permeability of their membranes, and also normalizes the activity of many of their membrane proteins (Medvedev, 2018a; Zavalishina, 2018a).

In the case of a systematic increase in muscle activity in the blood of young men who previously did not exercise physically, the number of transformed erythrocytes to varying degrees decreased and the level of erythrocytes having a discoid shape increased. It can be thought that a decrease in the number of altered erythrocytes in young men promotes inhibition of erythrocyte aggregation in their blood, improving blood circulation in all internal organs (Mal *et al*., 2018b; Zavalishina, 2018b).

Conclusion

Low muscle activity, even in adolescence, negatively affects the state of the entire body. An important mechanism for this is an increase in the level of red blood cells in the blood, which have a differently altered shape. These changes rapidly impair the process of all blood circulation through the capillaries, which weakens all types of metabolism. It was possible to find out that young men studying at the university with low fitness, as a result of regular sports walking, demonstrate a weakening of lipid imbalance and lipid peroxidation processes in erythrocytes. In those who have started regular physical training, the level of altered variants of erythrocytes decreases in the blood, which has a very positive effect on blood circulation and metabolism in their organs. The pronounced improvement of microrheological characteristics of erythrocytes achieved in poorly trained young men after 6 months of race walking gives grounds for a broad recommendation of this variant of physical activity to university students to improve their health.

Acknowledgments: The team of authors thanks the administration of the Russian State Social University for the opportunity to research its basis.

Conflict of interest: None

Financial support: None

Ethics statement: The study was approved by the local ethics committee of the Russian State Social University on September 15, 2019 (protocol №11).

References

Aldhairyan, A. H., Alyami, S. S. H., Alsaad, A. M. S., Al Shuqayfah, N. I., Alotaibi, N. A., Mujammami, N. M., Alkhathami, J. F., AlZahrani, Y. A., Ashaari, A. Y., & Alshehri, M. A. (2022). Gastroesophageal reflux disease: diagnosis and management approach, literature review. *World Journal of Environmental Biosciences, 11*(1), 1-3. doi:10.51847/EvuxMWxAai

Amelina, I. V., & Medvedev, I. N. (2009). Transcriptional activity of chromosome nucleolar organizing regions in population of Kursk region. *Bulletin of Experimental Biology and Medicine, 147*(6), 730-732.

Azhar, A. S., Muneer, A. S., & Kaleem, A. S. (2019). Fatigue: impact of muscular co-ordination among rifle shooters. *International Journal of Pharmaceutical Research & Allied Sciences, 8*(1), 123-128

Bespalov, D. V., Medvedev, I. N., Mal, G. S., & Makurina, O. N. (2018b). Functional activity of the vascular endothelium in patients with initial signs of atherosclerosis against the background of regularly dose-related exercise stress. *Research Journal of Pharmaceutical, Biological, and Chemical Sciences, 9*(2), 1020-1024.

Bespalov, D. V., Medvedev, I. N., Mal, G. S., & Polyakova, O. V. (2018a). Physiological capabilities of the vascular endothelium with the developing arterial hypertension in people of different ages who had long had low physical activity. *Research Journal of Pharmaceutical, Biological, and Chemical Sciences, 9*(2), 972-976.

Dembo, A. G., & Zemtsovsky, E. V. (1989). Sports cardiology. Leningrad: Medicine, 364.

Glagoleva, T. I., & Medvedev, I. N. (2020). Physiological features of aggregation of the main formed elements of blood in calves at the beginning of early ontogenesis 00161. Published online: 28 February 2020. doi:10.1051/bioconf/20201700161

Glagoleva, T. I., Zavalishina, S. Yu., Mal, G. S., Makurina, O. N., & Skorjatina, I. A. (2018). Physiological features of hemo-coagulation in sows during sucking. *Research Journal of Pharmaceutical, Biological, and Chemical Sciences, 9*(4), 29-33.

Glamazdin, I. G., Medvedev, I. N., Sysoeva, N. Y., Goryacheva, M. M., Kryukovskaya, G. M., & Maryushina, T. O. (2021). The severity of changes in the levels of formed elements in the blood of pigs with different types of higher activity in the conditions of their use of eleovite. *Bioscience Biotechnology Research Communications, 14*(1), 161-171.

Halimah, E., Hendriani, R., Indradi, B., & Sofian, F. F. (2022). Cytotoxicity of ethanol extract and its fractions from *Acalypha wilkesiana* against breast cancer cell MCF-7.

Journal of Advanced Pharmacy Education and Research, 12(1), 17-20. doi:10.51847/G2bMkvc6PO

Jose, E. J. B., Azariah, J. S., Radhakrishnan, M., Rajagopal, K., Sundaramoorthy, M., & Pillai, N. P. (2022). Comparative Study on the Phyllanthus Acidus and Phyllanthus Embilca and their Antimicrobial Activity. *International Journal of Pharmaceutical and Phytopharmacological Research, 12*(1), 1-6. doi:10.51847/9CSOk0twSN

Karpov, V. Y., Zavalishina, S. Y., Bakulina, E. D., Dorontsev, A. V., Gusev, A. V., Fedorova, T. Y., & Okolelova, V. A. (2021b). The physiological response of the body to low temperatures. *Journal of Biochemical Technology, 12*(1), 27-31. doi:10.51847/m1aah69aPr

Karpov, V. Yu., Medvedev, I. N., Dorontsev, A. V., Svetlichkina, A. A., & Boldov, A. S. (2020a). The state of cardiac activity in greco-roman wrestlers on the background of different options for weight loss. *Bioscience Biotechnology Research Communications*, *13*(4), 1842-1846.

Karpov, V. Yu., Zavalishina, S. Yu., Komarov, M. N., & Koziakov, R. V. (2020b). The potential of health tourism regarding stimulation of functional capabilities of the cardiovascular system. *Bioscience Biotechnology Research Communications*, *13*(1), 156-159. doi:10.21786/bbrc/13.1/28

Karpov, V. Yu., Zavalishina, S. Yu., Marinina, N. N., Skorosov, K. K., Kumantsova, E. S., & Belyakova, E. V. (2021a). Possibilities of regular physical culture lessons in restoring the functional status of students. *Journal of Biochemical Technology*, *12*(2), 62-66. https://jbiochemtech.com/wDCYQLtIxh

Khitrov, N. K., & Paukov, V. S. (1991). Adaptation of the heart to hypoxia. Moscow: Medicine, 235.

Liu, M., Tang, Q., Wang, Q., Xie, W., Fan, J., Tang, S., Liu, W., Zhou, Y., & Deng, X. (2022). Studying the sleep quality of first pregnant women in the third trimester of pregnancy and some factors related to it. *Journal of Integrative Nursing and Palliative Care, 3*, 1-6. doi:10.51847/K1PUWsJ24H

Makhoahle, P., & Gaseitsiwe, T. (2022). Efficacy of disinfectants on common laboratory surface microorganisms at R.S mangaliso hospital, NHLS laboratory, South Africa. *Bulletin of Pioneering Researches of Medical and Clinical Science, 1*(1), 1-12. doi:10.51847/d5bXpXAtcI

Makhov, A. S., & Medvedev, I. N. (2018a). Functional mechanisms to ensure the reactivity of the organism. *Research Journal of Pharmaceutical, Biological, and Chemical Sciences, 9*(6), 924-929.

Makhov, A. S., & Medvedev, I. N. (2018b). Evaluation of the effectiveness of the complex rehabilitation of children with oligophrenia in the degree of imbecility, who underwent fracture of the lower limb. *Research Journal of Pharmaceutical, Biological, and Chemical Sciences*, *9*(2), 731-736.

Makhov, A. S., & Medvedev, I. N. (2018c). The Effect of Physical Activity on Neurophysiological Processes in Students. *Research Journal of Pharmaceutical, Biological, and Chemical Sciences, 9*(6), 968-972.

Makhov, A. S., & Medvedev, I. N. (2021). Physiological effects of regular football training in adolescents using visual analyzer pathology. *Bioscience Biotechnology Research Communications*, *14*(2), 853-857.

Mal, G. S., Kharitonov, E. L., Vorobyeva, N. V., Makhova, A. V., & Medvedev, I. N. (2018a). Functional aspects of body resistance. *Research Journal of Pharmaceutical, Biological, and Chemical Sciences, 9*(6), 60-65.

Mal, G. S., Medvedev, I. N., & Makurina, O. N. (2020). The prevalence of extreme severity of autoaggression among residents of Russia. *Bioscience Biotechnology Research Communications, 13*(4), 2125-2129.

Mal, G. S., Vorobyeva, N. V., Makhova, A. V., Medvedev, I. N., & Fayzullina, I. I. (2018b). Features of physical rehabilitation after myocardial infarction. *Research Journal of Pharmaceutical, Biological, and Chemical Sciences, 9*(6), 280-285.

Medvedev, I. N. (2018a). Functional features of intravascular platelet activity in adolescents with high normal blood pressure, overweight or a combination of them against the background of regular physical exertion. *Research Journal of Pharmaceutical, Biological, and Chemical Sciences, 9*(6), 1258-1265.

Medvedev, I. N. (2018b). Physiological dynamics of erythrocytes' cytoarchitecture in aged rats. *Research Journal of Pharmaceutical, Biological, and Chemical Sciences*, *9*(1), 736-740.

Medvedev, I. N. (2018c). Physiological response of intravascular platelet activity in boys with high normal blood pressure to regular physical exercise. *Research Journal of Pharmaceutical, Biological, and Chemical Sciences*, *9*(6), 1244-1250.

Medvedev, I. N. (2018d). Vascular disaggregative control over neutrophils in patients with arterial hypertension and dyslipidemia. *Research Journal of Pharmaceutical, Biological, and Chemical Sciences*, *9*(1), 864-869.

Medvedev, I. N. (2018e). The physiological properties of platelets in people 18-35 years old, trained in the section of general physical training. *Research Journal of Pharmaceutical, Biological, and Chemical Sciences, 9*(6), 1277-1283.

Medvedev, I. N. (2018f). Dynamics of functional parameters of platelet hemostasis in young people with hemodynamic and metabolic disorders on the background of regular physical activity. *Research Journal of Pharmaceutical, Biological, and Chemical Sciences*, *9*(6), 1217-1222.

Medvedev, I. N. (2018g). Features of disaggregation effects of blood vessels on neutrophils in patients with hyperuricemia. *Research Journal of Pharmaceutical, Biological, and Chemical Sciences*, *9*(4), 740-745.

Medvedev, I. N. (2018h). Physiological response of platelet activity in young people with high normal blood pressure to regular exercise. *Research Journal of Pharmaceutical, Biological, and Chemical Sciences*, *9*(6), 1489-1494.

Medvedev, I. N. (2021). Dynamics of functional indicators of adolescents against the background of regular volleyball trainings. *Bioscience Biotechnology Research Communications*, *14*(2), 714-718.

Medvedev, I. N., & Skoryatina, I. A. (2014). Pravastatin in correction of vessel wall antiplatelet control over the blood

cells in patients with arterial hypertension and dyslipidemia. *Cardiovascular Therapy and Prevention*, *13*(6), 18-22.

Medvedev, I. N., & Zavalishina, S. Yu. (2016). Platelet activity in patients with third degree arterial hypertension and metabolic syndrome. *Kardiologiia*, *56*(1), 48.

Medvedev, I. N., Karpov, V. Yu., Eremin, M. V., Boldov, A. S., Shalupin, V. I., Voronova, N. N., & Malyshev, A. V. (2021). The functional characteristics of the organism of physically inactive students who have started regular physical training. *Journal of Biochemical Technology*, *12*(2), 33-37.

Moubarez, D. A., Mohamed, K. A. E. A., El Din, S. S., Basheer, M. A., & El Baz, A. A. E. R. (2019). Muscle ultrasound in assessment of critical illness neuromyopathy in comparison with nerve conduction. *Journal of Advanced Pharmacy Education & Research*, *9*(1), 11-16.

Shaheen, R. S., Alsaffan, A. D., Al-Dusari, R. S., Helmi, R. N., & Baseer, M. A. (2022). Self-perceived oral hygiene and periodontal health among dental and medical students, dentists and physicians in KSA. *Annals of Dental Specialty*, *10*(1), 126-132. doi:10.51847/NVcZEJ0YBV

Skoryatina, I. A., & Medvedev, I. N. (2019). Correction of aggregation level of basic regular blood elements in patients with hypertension and dyslipidemia receiving rosuvastatin and non-medicinal treatment. *Bali Medical Journal*, *8*(1), 194-200.

Skoryatina, I. A., & Zavalishina, S. Yu. (2017). Ability to aggregation of basic regular blood elements of patients with hypertension and dyslipidemia receiving non-medication and simvastatin. *Bali Medical Journal*, *6*(3), 521-528. doi:10.15562/bmj.v6i3.553

Tkacheva, E. S., & Zavalishina, S. Yu. (2018a). Physiological features of platelet aggregation in newborn piglets. *Research Journal of Pharmaceutical, Biological, and Chemical Sciences*, *9*(5), 36-42.

Tkacheva, E. S., & Zavalishina, S. Yu. (2018b). Physiology of platelet hemostasis in piglets during the phase of newborns. *Research Journal of Pharmaceutical, Biological, and Chemical Sciences*, *9*(5), 1912-1918.

Vorobyeva, N. V., Mal, G. S., Zavalishina, S. Yu., Glagoleva, T. I. & Fayzullina, I. I. (2018). Influence of physical exercise on the activity of brain processes. *Research Journal of Pharmaceutical, Biological, and Chemical Sciences*, *9*(6), 240-244.

Zavalishina, S. Y., Bakulina, E. D., Eremin, M. V., Kumantsova, E. S., Dorontsev, A. V., & Petina, E. S. (2021b). Functional changes in the human body in the model of acute respiratory infection. *Journal of Biochemical Technology*, *12*(1), 22-26. doi:10.51847/F8mofsugnZ

Zavalishina, S. Y., Karpov, V. Y., Zagorodnikova, A. Y., Ryazantsev, A. A., Alikhojin, R. R., & Voronova, N. N. (2021c). Functional mechanisms for maintaining posture in humans during ontogenesis. *Journal of Biochemical Technology*, *12*(1), 36-39. doi:10.51847/5LNdtyTcdH

Zavalishina, S. Yu. (2018a). Functional properties of anticoagulant and fibrinolytic activity of blood plasma in calves in the phase of milk nutrition. *Research Journal of Pharmaceutical, Biological, and Chemical Sciences*, *9*(5), 659-664.

Zavalishina, S. Yu. (2018b). Functional properties of fibrinolysis in calves of the first year of life. *Research Journal of Pharmaceutical, Biological, and Chemical Sciences*, *9*(5), 870-876.

Zavalishina, S. Yu. (2018c). Physiological features of coagulation in calves of plant nutrition. *Research Journal of Pharmaceutical, Biological, and Chemical Sciences*, *9*(5), 899-904.

Zavalishina, S. Yu. (2018d). Physiological dynamics of the blood coagulation system activity in calves during the phase of dairy nutrition. *Research Journal of Pharmaceutical, Biological, and Chemical Sciences*, *9*(5), 680-685.

Zavalishina, S. Yu. (2018e). Physiological mechanisms of hemostasis in living organisms. *Research Journal of Pharmaceutical, Biological, and Chemical Sciences*, *9*(5), 629-634.

Zavalishina, S. Yu. (2018f). Functional activity of vascular hemostasis in newborn calves with iron deficiency. *Research Journal of Pharmaceutical, Biological, and Chemical Sciences*, *9*(6), 1490-1496.

Zavalishina, S. Yu. (2018g). Functional activity of thrombocytes in newborn calves. *Research Journal of Pharmaceutical, Biological, and Chemical Sciences*, *9*(5), 919-924.

Zavalishina, S. Yu. (2020). Functional activity of the cardiorespiratory system and the general level of physical capabilities against the background of regular physical exertion. *Bioscience Biotechnology Research Communications*, *13*(4), 2327-2331. doi:10.21786/bbrc/13.4/105

Zavalishina, S. Yu., Karpov, V. Yu., Rysakova, O. G., Rodionov, I. A., Pryanikova, N. G., & Shulgin, A. M. (2021a). Physiological reaction of the body of students to regular physical activity. *Journal of Biochemical Technology*, *12*(2), 44-47. doi:10.51847/ERJ8YmdKPC

Zavalishina, S. Yu., Makurina, O. N., Vorobyeva, N. V., Mal, G. S., & Glagoleva, T. I. (2018). Physiological features of surface properties of the erythrocyte membrane in newborn piglets. *Research Journal of Pharmaceutical, Biological, and Chemical Sciences*, *9*(4), 34-38.