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Hematological Indicators of Students Who Started Races

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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

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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). 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; Glamazdin *et al*., 2021). 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

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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). 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). 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). 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). 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).

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. 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). This is because optimization of the content of phospholipids and cholesterol in erythrocyte membranes has a pronounced positive effect on their functions. 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.

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