THE INFLUENCE OF SPRINT TRAINING ON CHANGES IN THE MORPHOLOGICAL AND RHEOLOGICAL PROPERTIES OF THE BLOOD

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Key words: morfologia krwi, reologia krwi, elongacja, agregacja, lekkoatletyka, biegi, sprint, blood morphology, blood rheology, elongation, aggregation, track-and-field, running, sprint

Abstract

Aim. The aim of the work is to present morphological and rheological changes in the blood of sprinters under the influence of preparatory training for sport competitions.

Basic procedures. The research was carried out among a group of 10 sprinters from the AZS AWF Krakow Sports Club within the 21-25 age group. The average duration of professionally performing track-and-field among the studied group was 6 years. The athletes were preparing for the Indoor Polish Track-and-Field Championship. 5 ml of blood was collected from the athlete’s ulnar vein before the preparatory season and just before the Polish Indoor Championship (after 121 days of training).

Results. A statistically significant reduction in MCH [pg], MCHC [g/dl], fibrinogen [g/l] and AMP [au], and statistically significant increases in RBC [106/mm3], HCT [%], EI [Pa] for 0.58-15.98 [Pa] shear stress were found, while there were no changes in the aggregation of erythrocytes.

Conclusions. Specialized sprint training has a positive effect on morphological and rheological changes in the blood.

Introduction

The sprint, otherwise known as short runs, is considered to be the “queen of sport”, thus track-and-field. The sprint distances include: 100 m, 200 m, 400 m for women and men. Despite the different distances, these competitions have many common features. We may include items such as: crouch-start, start-up phase, distance runs, finish line attack – the finish and stop phase after crossing the finish line. In the Antiquity, only one running competition called a sprint took place at the Olympics. The competitors had to overcome one lap of the stadium, which was 192.27 m. Initially, the sprint was introduced at the beginning of the 19th cen-
tury at English universities, and in the mid-19th century also at school competitions. Until 1968, the results of sprints were recorded with an accuracy of 0.1 s, and then 0.01 s [1, 2].

Rheology is a field of science that deals with deformability and the study of blood flow in the vascular system. This applies to all blood, plasma and morphotic elements. The most numerous group of blood cells are erythrocytes, which is why they have the greatest influence on the mechanical properties of blood. The rheological properties of blood are determined by factors such as blood viscosity, plasma viscosity, hematocrit, aggregation, erythrocyte deformability and fibrinogen concentration [3].

The deformability of erythrocytes plays a very important role in the proper functioning of the body. Due to the specific structure and function of the erythrocyte membrane, it is possible for erythrocytes to squeeze through vascular networks. Under the influence of shear stress, red blood cells change their shape from round to ellipsoid, ensuring flexibility of their membranes, the shape of the cell and intrinsic viscosity. Red blood cells, after returning to a larger vessel, go back to their original shape without disturbing their function and properties [4].

The aim of this work is to present morphological and rheological changes of the blood in sprinters under the influence of preparatory training for sport competitions.

**Study design**

The study group consisted of ten sprinters (n = 10), running the distances of 100 m, 200 m and 400 m from the AZS AWF Kraków Sports Club (University of Physical Education Academic Sports Association) within the 21-25 age group. Five individuals from the study group ran 100 m and 200 m and the remaining five ran 200 m and 400 m. The average duration of professionally performing track-and-field in the studied group was 6 years. The athletes were preparing for the 2018 Indoor Polish Track-and-Field Championship. The competitors started training in October, and the target event took place in February. Each training unit lasted 2 hours. The training period was divided into 4 parts: initial preparation lasting 31 days, specialized preparation of 46 days, pre-start preparation lasting 31 days and a 13-day start-up period. The description of individual training cycles is presented in Table 1.

Blood was collected from the athletes for testing at Bronislaw Czech University of Physical Education Department of Laboratory of Musculoskeletal Pathology in Krakow at the beginning of the preparatory season and just before the indoor competitions. In order to conduct the tests, 5 ml of blood was collected from the ulnar vein and put into VACUETTE tubes with K3EDTA. Blood collection was performed in a fasting state and the material was taken by a qualified nurse under the supervision of a physician. The samples were tested in the above-mentioned laboratory. Permission of the Bioethical Commission at the District Medical Chamber in Krakow was issued for conducting research.

Blood morphology

Measurements were performed using the ABX MICROS 60 hematology analyser (USA). The following indices were marked:

<table>
<thead>
<tr>
<th>Duration</th>
<th>Aim</th>
<th>Type of training</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preliminary preparation</td>
<td>– work on aerobic endurance</td>
<td>– aerobic training (running games)</td>
</tr>
<tr>
<td></td>
<td>– general preparation</td>
<td>– circuit training at the gym</td>
</tr>
<tr>
<td></td>
<td></td>
<td>– motor preparation of the athletes</td>
</tr>
<tr>
<td>Specialized preparation</td>
<td>– building general and specialized strength</td>
<td>– circuit training</td>
</tr>
<tr>
<td></td>
<td>– work on pace endurance</td>
<td>– strength training (selected specialized exercises)</td>
</tr>
<tr>
<td></td>
<td>– improvement of aerobic endurance</td>
<td>– aerobic training</td>
</tr>
<tr>
<td></td>
<td></td>
<td>– pace endurance training</td>
</tr>
<tr>
<td>Pre-start preparation</td>
<td>– improving pace endurance</td>
<td>– pace endurance training</td>
</tr>
<tr>
<td></td>
<td>– improvement of speed endurance</td>
<td>– speed endurance training</td>
</tr>
<tr>
<td></td>
<td>– maintaining specialized strength</td>
<td>– strength training</td>
</tr>
<tr>
<td></td>
<td>– work on dynamics</td>
<td>– speed training</td>
</tr>
<tr>
<td>Starting preparation</td>
<td>– improving speed endurance</td>
<td>– speed endurance training</td>
</tr>
<tr>
<td></td>
<td>– speed improvement</td>
<td>– plyometric training</td>
</tr>
<tr>
<td></td>
<td>– power improvement</td>
<td></td>
</tr>
</tbody>
</table>
1. The number of red blood cells – RBC \([10^6/mm^3]\)
2. Hematocrit – Hct [%]
3. Hemoglobin – Hgb \([g/dl]\)
4. Index for average mass of hemoglobin in a red blood cell – MCH [pg]
5. Index for average red cell volume – MCV [fl]
6. Average hemoglobin concentration in a red blood cell – MCHC [g/dl]
7. The number of white blood cells – WBC \([10^3/mm^3]\)
8. Platelet count – PLT \([10^3/mm^3]\)

Marking the elongation and aggregation indices

The LORRCA analyser (Laser-assisted Optical Rotational Cell Analyzer, RR Mechatronics, Netherlands) was used to study the deformability of erythrocytes. The results were obtained as elongation and aggregation indices, according to the Hardeman method [5, 6]. Tests using the abovementioned apparatus were carried out within 30 minutes after blood sampling, at 37°C and according to standard protocol.

Marking the elongation index

Blood for the determination of elongation index was collected in an amount of 25 µl to 5 ml 0.14 mM PVP (polyvinylpyrrolidone, M=360,000, Sigma, viscosity at 37°C above 31 mPa) and dissolved in phosphate buffered saline (PBS). The test sample was placed in a measuring chamber between two rotating concentric cylinders. The laser light passing through the thin layer of red blood cells suspended in PBS underwent deflection, providing a diffraction pattern on the projection screen. The deflection pattern was recorded with a video camera and then transferred to a computer, and is dependent on the value of shear rate acting on the blood cell during the rotation of the cylinder. However, as the tension rises, the shape of the diffraction pattern shifts from a circle to an ellipse with an increasing ratio of the long axis “a” to the short “b”. The index was calculated by:

\[
El = \frac{a - b}{a + b}
\]

The elongation index (EI) results are given within the range from 0.30 to 60.30 of shear stress measured in Pascals. The elongation index is a measure of the value of red blood cell deformation while being subjected to centrifugal force in the measuring chamber [5, 6].

Marking the aggregation index

The blood sample was subjected to oxygenation prior to actual testing by incubation and mixing it with carbogen within 15 minutes. Blood in the amount of 1.5 ml was introduced into the LORCA analyser measuring chamber. The result of computer analysis is a curve representing the intensity of scattered light depending on time (for a given shear rate), i.e. selectogram [7, 8]. The following parameters were tested:

- AI [%] – aggregation index
- AMP [au] – the degree of total aggregation
- T½ [s] – half-life of total aggregation

Marking the plasma

50 µl of plasma was used for the study. Marking was performed using the Bio-Ksel, Chrom – 7 camera. The applied method consisted in measuring the change in optical density which occurred during the coagulation reaction. The time was measured from the moment of adding a reagent containing calcium chloride to the time of forming a clot, and the result is given in g/l.

Statistical analysis

To compare the data before the preparatory season and when the athlete was in top form, the Student’s t test for dependent samples and the Wilcoxon test were used, first checking the necessary assumptions regarding normal distribution of differences. A significance level of \(\alpha = 0.05\) was assumed. The average and standard deviations were taken into account in the analysis. The collected data was subjected to statistical analysis using the STATISTICA 13.1 programme (StatSoft®, Poland).

Results

Comparing the indices before the preparatory season and during the top-form of the athletes (after 121 days of training), a statistically significant increase in RBC \([10^6/mm^3]\) by 4.14%, HCT [%] by 3.97% and EI with shear stress of 0.58-15.98 \([Pa]\) and a decrease in MCH [pg] by 3.92%, MCHC [g/dl] by 3.68%, fibrinogen [g/l] by 46.93% and AMP [au] by 23.11% were noted. The average value of EI [Pa] significantly increased when the

![Figure 1](image_url)
Figure 2. Graph presenting the average value of HCT [%] in sprinters before the preparatory season and when in top form

Figure 3. Graph presenting the average RBC [pg] hemoglobin mass in sprinters before the preparatory season and when in top form

Figure 4. Graph presenting the erythrocyte hemoglobin concentration [g/dl] in sprinters before the preparatory season and when in top form

Figure 5. Graph presenting the average EI values [Pa] in sprinters before the preparatory season and when in top form

Figure 6. Graph presenting the average fibrinogen concentration [g/l] in sprinters before the preparatory season and when in top form

Figure 7. Graph presenting the average degree of total aggregation [%] in sprinters before the preparatory season and when in top form
athlete was in top form compared to the average value of EI [Pa] before the preparatory season. Comparing the results of EI [Pa] before the preparatory season and when in top form, the following statistically significant changes can be observed at the shear stress of: 0.58 [Pa] increase by 33.33%, 1.13 [Pa] increase by 40.00%, with shear stress 2.19 [Pa] increase by 37.50%, with shear stress 4.24 [Pa] increase of 36.36%, with shear stress 8.24 [Pa] increase of 33.33% and at shear stress 15.98 [Pa] increase by 32.26%. There were no changes in the aggregation of erythrocytes (Table 2, Figures 1-7.).

### Discussion

The aim of the study was to show changes in morphological and rheological properties of the blood among sprinters under the influence of preparatory training for the most important event of the winter season – the 2018 Indoor Polish Championship.

There are no studies in international or Polish literature showing changes in the morphological and rheological properties of the blood in sprints. The conducted research is mainly based on the changes of rheological properties in the blood of long-distance runners (marathon runners, ultra-marathoners) under the influence of a single, maximum physical effort. These athletes were tested just before and after the competition. This topic was addressed, among others, by Dąbrowski et al. [9], Jastrzębski et al. [10] and Mleczko et al. [11].

Sprint training is a diverse workout. It is not solely based on perfecting one feature. It includes anaerobic and aerobic training, strength and technique. The most important is anaerobic endurance because in sprints, the main source of energy is anaerobic metabolism [12].

Kilgore et al. hypothesized that a specific training programme including endurance, strength, power, jumps and sprints is the most responsible for changes in hemoglobin concentration, hematocrit value and the amount of erythrocytes in the blood [13]. Brun et al. [14] showed that a lower level of hematocrit in highly trained people compared to non-training individuals affects the higher level of aerobic capacity, and a too excessive level of he-

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### Table 2. Average values ± standard deviation of selected morphological and rheological parameters in sprinters before the preparatory season and when in top form

<table>
<thead>
<tr>
<th>Indices</th>
<th>Before the preparatory season</th>
<th>In top form</th>
<th>Level of significance</th>
<th>Change [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>WBC [10³/mm³]</td>
<td>5.62±0.94</td>
<td>6.01±1.31</td>
<td>0.1265</td>
<td>6.94</td>
</tr>
<tr>
<td>RBC [10⁶/mm³]</td>
<td>4.35±0.27</td>
<td>4.53±0.29</td>
<td>0.0029</td>
<td>4.14</td>
</tr>
<tr>
<td>HGB [g/dl]</td>
<td>13.81±0.70</td>
<td>13.84±0.85</td>
<td>0.8443</td>
<td>0.22</td>
</tr>
<tr>
<td>HCT [%]</td>
<td>38.00±1.84</td>
<td>39.51±2.22</td>
<td>0.0171</td>
<td>3.97</td>
</tr>
<tr>
<td>MCV [fl]</td>
<td>87.50±2.64</td>
<td>87.30±2.63</td>
<td>0.7163</td>
<td>0.23</td>
</tr>
<tr>
<td>MCH [pg]</td>
<td>31.82±1.94</td>
<td>30.57±1.26</td>
<td>0.0018</td>
<td>3.92</td>
</tr>
<tr>
<td>MCHC [g/dl]</td>
<td>36.39±1.38</td>
<td>35.05±1.03</td>
<td>0.0032</td>
<td>3.68</td>
</tr>
<tr>
<td>PLT [10³/mm³]</td>
<td>191.20±29.90</td>
<td>180.30±34.42</td>
<td>0.3459</td>
<td>5.70</td>
</tr>
<tr>
<td>Fibrynogen [g/l]</td>
<td>2.94±1.58</td>
<td>1.56±0.47</td>
<td>0.0366</td>
<td>46.93</td>
</tr>
<tr>
<td>El 0.30 [Pa]</td>
<td>0.04±0.02</td>
<td>0.06±0.02</td>
<td>0.0694</td>
<td>50.00</td>
</tr>
<tr>
<td>El 0.58 [Pa]</td>
<td>0.06±0.01</td>
<td>0.08±0.01</td>
<td>0.0060</td>
<td>33.33</td>
</tr>
<tr>
<td>El 1.13 [Pa]</td>
<td>0.10±0.02</td>
<td>0.14±0.01</td>
<td>0.0012</td>
<td>40.00</td>
</tr>
<tr>
<td>El 2.19 [Pa]</td>
<td>0.16±0.03</td>
<td>0.22±0.03</td>
<td>0.0027</td>
<td>37.50</td>
</tr>
<tr>
<td>El 4.24 [Pa]</td>
<td>0.22±0.05</td>
<td>0.30±0.05</td>
<td>0.0147</td>
<td>36.36</td>
</tr>
<tr>
<td>El 8.24 [Pa]</td>
<td>0.27±0.07</td>
<td>0.36±0.06</td>
<td>0.0278</td>
<td>33.33</td>
</tr>
<tr>
<td>El 15.98 [Pa]</td>
<td>0.31±0.08</td>
<td>0.41±0.07</td>
<td>0.0409</td>
<td>32.26</td>
</tr>
<tr>
<td>El 31.03 [Pa]</td>
<td>0.35±0.10</td>
<td>0.45±0.07</td>
<td>0.0656</td>
<td>28.57</td>
</tr>
<tr>
<td>El 60.30 [Pa]</td>
<td>0.37±0.11</td>
<td>0.47±0.07</td>
<td>0.0710</td>
<td>27.03</td>
</tr>
<tr>
<td>AMP [au]</td>
<td>18.87±3.56</td>
<td>14.51±4.27</td>
<td>0.0127</td>
<td>23.11</td>
</tr>
<tr>
<td>T1/2 [s]</td>
<td>3.96±1.03</td>
<td>2.86±1.60</td>
<td>0.0564</td>
<td>27.78</td>
</tr>
<tr>
<td>AI [%]</td>
<td>49.88±6.08</td>
<td>58.63±14.57</td>
<td>0.0767</td>
<td>17.54</td>
</tr>
</tbody>
</table>

*level of significance $p \leq 0.05$
matocrit (> 44.6%) leads to overtraining, anaemia and increased blood viscosity [14]. Silva et al. [15] observed that during the 3-month training programme, there was an increase in red blood cell count, while different results were found in the research by Mann et al. [16], who suggest a reduction in these parameters.

Blood viscosity is a basic rheological parameter. It depends on the concentration of hemoglobin in an erythrocyte, the number of erythrocytes and leukocytes, protein concentration and hematocrit value. It changes depending on shear rate and the diameter of blood vessels. According to the Fahraeus-Lindqvist effect, blood viscosity decreases along with the decrease in vessel diameter [17]. The most important factor responsible for the resistance of blood flow is blood viscosity, which is the ratio of shear stress to shear rate [2, 18].

An increase in plasma viscosity contributes to an increase in blood viscosity, with a constant level of other determinants. One of the reasons for increasing the viscosity of plasma is to increase protein concentration. It should be noted, however, that different proteins cause different effects, and they often depend on the shape and size of proteins, especially fibrinogen [2, 18].

Tangential stress is the force exerted on a liquid. The blood begins to flow after the tangential stress value is exceeded. The application of specific tangential stress results in a suitable flow velocity and this is the shear rate. The higher the shear stress, the greater the blood viscosity [2, 18].

Research shows that decreasing blood flow increases blood viscosity and hematocrit. At a low shear rate and with an increase in hematocrit, there is a greater probability of aggregation. On the other hand, at a high shear rate, the number of red blood cells increases. It was observed that hematocrit value within the normal range slightly affects the blood viscosity, whereas an increase of this index above 50% results in a significant increase [2, 18, 19].

Under the influence of regular physical training, a decrease in the MCHC level was observed, which is closely related to the increased elasticity of red blood cells [20, 21].

The decreasing level of MCHC under the influence of physical exercise is also confirmed in the research of Green et al. [22], who proved that under the influence of daily, 2-hour training sessions, VO2max increases by 17% and this is closely related to a 18% reduction in MCHC. This research suggests that physical training shortens the lifespan of red blood cells because it leads to faster haemolysis which causes the replacement of old blood cells with new ones. New erythrocytes are larger and more efficiently transport oxygen to tissues [22].

In the conducted studies, a statistically significant reduction in the MCHC level by 3.68% was found and MCH by 3.92% in top-form athletes compared to results from before the preparatory season. These are adaptive changes occurring in the athlete’s body under the influence of regular physical training. Lowering these parameters is closely related to increasing the elasticity of red blood cells. Thanks to this, it is possible to have better blood flow and to supply an adequate amount of oxygen to the working muscles [20, 21, 23].

The norm for MCHC is 32-36 g/dl. Before the preparatory season, the average value of MCHC [g/dl] was 36.39 g/dl, while in athletes top of their form, the average value of MCHC [g/dl] was 35.05 g/dl. This result is within the physiological norm. The norm for MCH is 27-31 pg. Before the preparatory season, the average value of MCH [pg] was 31.82 pg, and in the top of form, 30.57 pg.

In their study, Brun et al. showed that under the influence of regular, long-term training, there is a decrease in the level of fibrinogen in the blood plasma and this is closely related to the reduction of erythrocyte aggregation [24]. Letcher et al. described rheological changes in the blood of people training professionally compared to those non-training. From these studies, it also follows that under the influence of training, there is a significant reduction of fibrinogen level in the plasma [25]. In the study by Ernest et al., a significant decrease in fibrinogen level was observed after 3 weeks of training and after 6 weeks of training, the results maintained at the same level, while after 10 weeks, a statistically significant decrease in fibrinogen level was noted. The authors explain this decrease in fibrinogen levels under the influence of physical training as a beneficial effect on the cardiovascular system [23].

Kilic-Toprak et al. conducted a study aimed at demonstrating the hemororheological changes of the blood under the influence of strength training. They proved that due to the 12-week training programme, in the case of low and medium values of shear stress, there was a statistically significant increase in elongation index [26]. The Cakir-Atabek et al. study also showed that elongation index increased under the influence of the 6-week training programme [27].

Despite many studies dealing with changes in erythrocyte aggregation under the influence of physical effort, different sources present different changes. The reason is, among others, due to various methods of aggregation index measurement. Unfortunately, changes in the aggregation of erythrocytes under the influence of sprint training have not yet been studied. All available studies refer to changes in the aggregation of red blood cells due to a single physical effort [9]. In their research, Cakir-Atabek et al. conducted studies showing an increase in aggregation index under the influence of one intensive training unit in trained athletes and
a decrease in the aggregation index under the influence of a 6-week training period [27]. The reason for the increase in aggregation index is explained in the research by Brun et al. as overtraining, causing worsened results, despite intensive training [28]. Research by Biliske et al. indicate a statistically significant increase in AI and a decrease in T1/2 [29].

High levels of hematocrit increase the aggregation of red blood cells. This is a reversible phenomenon, characteristic of non-Newtonian fluids, conditioned by external factors: the level of plasma proteins, e.g. fibrinogen and internal: shape, membrane properties and erythrocyte deformability. Increased fibrinogen values promote "rouleaux" formation. The cellular properties of blood and mechanical properties of blood flow also have a significant effect on the aggregation of blood cells. Aggregation mainly takes place within small blood vessels because there is low shear force. These vessels create macro-molecular bridges in the erythrocyte membrane, which facilitates the 'rouleauxing' of RBC. The number of produced aggregates is influenced, among others, by the age of erythrocytes, the physicochemical properties of macromolecules, the shape of erythrocytes and the concentration of hemoglobin [30].

In our research, we observed a statistically significant increase in the amount of red blood cells by 4.14% and hematocrit value by 3.97% in the top-form athletes compared to the level before the preparatory season. An increase both the number of erythrocytes and the hematocrit level is considered to be an adaptive change of the body under the influence of regular physical exercise. What is more, the athletes were in high-mountain conditions during the preparatory period. Research by Robach et al. confirm the increase in the number of erythrocytes under the influence of physical exercise in high-mountain conditions. Increases in erythropoiesis, erythrocytes and hemoglobin were observed [31]. The study by Wehrlin et al. also confirms that training in high-mountain conditions contributes to an increase in erythropoiesis and, as a consequence, an increase in the number of red blood cells as well as hemoglobin [32]. Confirmation of the results obtained in this study can also be found in the research of Hu et al., who believe that the increase in hematocrit level is related to the improvement of oxygen transport and the increase in aerobic capacity [33].

The norm of erythrocytes for men is 4.5-5.9 10^6/mm^3. In the group under study before the preparatory season, the average number of erythrocytes was 4.35 10^6/mm^3, while for those the top form, it totalled 4.53 10^6/mm^3. In the research by Silva et al., the authors noticed that under the influence of training, an increase in red blood cell counts occurs. The reason for this increase in the indices is the reduction of plasma volume under the influence of the 3-month training period [16].

In our own research, we observed an increase in elongation index in athletes at the top of their form as compared to the results before the preparatory season. Statistically significant were the 0.58 [Pa], 1.13 [Pa], El 2.19 [Pa], El 4.24 [Pa], El 8.24 [Pa] and El 15.98 [Pa] values for shear stress. This is confirmation of previous studies carried out by Wahl et al. and Connes et al. who found an increase in elongation index after physical exercise in very well-trained individuals [34, 35]. The authors explain the higher deformability of erythrocytes under the influence of training as a beneficial effect influencing aerobic capacity by delivering more oxygen to tissues [34].

Fibrinogen plays not only an important role in blood rheology, but also affects the wound healing process, it participates in the body's inflammatory and defence mechanisms. A high level of fibrinogen is one of the factors accelerating the development of atherosclerosis and the occurrence of coronary diseases. The research by El Sayed shows that lowering fibrinogen levels in the human body is possible due to regular physical exercise [18].

The results of our study indicate a statistically significant decrease in the level of fibrinogen by 46.93% in the top-form athletes compared to the level of fibrinogen before the preparatory season. Mahmoud et al. lists a number of processes that lead to lowering fibrinogen levels. Under the influence of physical exercise, blood volume is increased, which is caused by an increase in plasma volume. As a consequence of the increase in plasma volume, the number of plasma proteins decreases, including fibrinogen [36].

This study shows a statistically insignificant increase in aggregation index (AI) and decrease in total aggregation half-life level (T1/2) as well as a significant statistical reduction in the mean degree of total aggregation (AMP) by 23.11%.

In summary, training has a beneficial effect on changes in the morphological and rheological properties of the blood because it influences a number of positive changes in an athlete’s body. There is an increase in the number of erythrocytes, the value of hematocrit and an increase in elongation index, thanks to which it is possible to transport more oxygen to the muscles at work. It also contributes to increasing aerobic capacity and lactate threshold of an athlete [33, 34].

Significant reductions in MCHC and MCH are associated with increased flexibility of erythrocytes. Thanks to this, it is possible for better blood flow through the vessels, providing more oxygen to the working muscles. Under the influence of the applied sprint training, a decrease in fibrinogen level in the blood was observed. This is a positive phenomenon, because a high level of fibrinogen contributes to the aggregation of
erythrocytes and this phenomenon slows down blood flow to the muscles [3, 18].

In conclusion, there are no existing studies in international and Polish literature related to changes in morphological and rheological properties of the blood in sprinters during sports training. Lack of research indicates the need to broaden analysis in this area.

Conclusions

The research confirms that the applied sprint training has a positive effect on selected rheological and morphological indices of the blood among the subjects and on the medal-success of sprinters during the Indoor Polish Championships in Track-and-Field.

References:

The influence of sprint training on changes...


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