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HIGH ALTITUDES EFFECTS ON HEMATOLOGIC BLOOD PARAMETERS

1. Introduction

Currently, training in high altitudes is a known effective method for improving essential human body systems efficacy by increasing the level of competitiveness of professional athletes for competitions.

Even though, many aspects of such trainings are little informed in the sport gyms.

Sport performance after training at high altitudes (2000 meters above sea level) effects the morphologic aspect of blood parameters.

This type of training stimulates the production of erythrocytes (responsible for transport of oxygen in blood), hemoglobin and blood circulation volume (in order that bigger amount of oxygen transfers to cells).

Training in high altitudes has become a decisive element in preparing the athletes for big competitions. The effects of high altitude environments in the athletes varies from many factors of which the most desirable and encouraging are the decreased level of oxygen pressure in the air. This combined with other factors such as difference in ambient temperature and increased air humidity combines for a real challenge for athletes.

Specifically, the aim and the objective of this study consists on verifying the change in blood parameters after a stay in a high altitude environment (1800-2300m) of student population during a 10 day ski-trip.

1.1 Changes of blood parameters during high altitude training

Physical exercise in high altitudes have started emerging in year 1950 when many experiments began by performing sport exercises in different atmospheric conditions and carrying analyses and also by studying the load effects of athletes in these conditions.

Such kind of training has reached its peak during the preparations for Mexico City Olympic games in 1968 that were held at an altitude of 2240 meters above sea level.

Exercises in conditions where the amount of oxygen in the air is smaller (hypoxia) result in many positive effects in physical preparation of athletes by which is made possible to achieve better sport results. With the increase of altitude, the atmospheric density decreases and the amount of oxygen the athlete intakes during exercise at high altitudes falls.

2. Aim of the study

This study was realized in order to verify the change of hematologic blood parameters that we will identify at the students before and after sport activities at high altitudes of 1800-2000 meters above sea level. As such for the purpose of verifying of this objective we have set two basic hypothesis:

H1: We expect to identify important changes of hematologic blood parameters after the exercise in high altitude.

H2: We expect to identify same changes of hematologic blood parameters according to gender.

2.1. Material and work methodology

In this work, 64 students of the faculty of sports sciences in University of Prishtina aged between 19 and 25 with an average of 21 were included. All students preliminary attended a medical test to check TA, Arterial Pulse and Respiratory frequency. A thorough medical test was carried to evaluate the subjects health condition. Additionally, blood tests of each subject were carried.

12 females and 52 male subjects were treated in this experiment all of the above-mentioned age group. Initially the blood samples of all the students were taken moments before leaving for the trip to Brezovica mountains where the exercises were to be carried and the blood test results for erythrocyte, hematocrit and hemoglobin were determined at an altitude of 560m.

For the tests, the blood was taken form the finger.

The same procedure was carried after the return from Brezovica Mountains. Blood samples were taken by the participants in the "Biotechnic Lab" in Prishtina and were processed in SWELAB ALFA machine.

Swelab Alfa Analyzer Standard is used in big laboratories with the main objective being the quality of the gained results by using high level hematologic systems, it is an automatic machine which helps us carry exact measures in short times.

2.2. Analysis and interpretation of experiment results

Based on the research material and processed data we have arrived to conclusion of this results which we expressed in table forms and graphics.

In table 1 the average level of hemoglobin in the female subjects of the experiment is expressed in table form and graphic before and after the 10 day stay at high altitude.

Before leaving for Brezovica Mountains the average level of hemoglobin in the female subjects was 123,9 g/L while the average level of Hemoglobin after returning from the trip was 127,8g/L

Table 1. Average level of hemoglobin of female subjects:

Hemoglobin level before the trip	123.9g/L
Hemoglobin level after the trip	127.8g/L

Based on this result we can notice that the level of hemoglobin has increased by 3,9g/L

In table number 2 the average level of erythrocytes for female subjects is expressed before and after the trip. The average level of erythrocytes was calculated for the female gender, before the trip this value was 4.09×10^{12}/L while after the trip the value was $4,42 \times 10^{12}$/L.

Table 2. Average levels of erythrocytes of female subjects:

Value of erythrocytes before the trip	**4.09×10^{12}/L**
Value of erythrocytes upon return	**4.42×10^{12}/L**

Based on this result we notice an increase of erythrocyte level by $0,33 \times 10^{12}$/L

In similar manner as in the previous to tables, in table number 3 we have expressed the average values of hematocrit for the female subjects before and after the trip to Brezovica. Before the trip the hematocrit level was 33.98% while upon return the level was 36.61%

Table 3.Average level of hematocrit for the female subjects

Average level of hematocrit before the trip	**33.98%**
Average level of hematocrit upon return	**36.61%**

Based on this result we notice an increase of hematocrit level by 2.63%.

In table number 4 we have expressed the increase in percentage of hemoglobin, erythrocytes and hematocrit in female subjects

Table 4.

Hemoglobin	**3.15%**
Erythrocytes	**8.60%**
Hematocrit	**7.74%**

While comparing the three parameters, the gained differences are analyzed in statistical manner and it's been concluded that the erythrocytes have encountered the bigger change out of the three tested parameters.

In Table 5 the average level of hemoglobin in the male subjects before and after the 10 day trip at altitude above 2000m is expressed

Before the trip to Brezovica the average level of hemoglobin for the male subjects was 147,6g?l while upon return from Brezovica the hemoglobin level was 152,7g/L

Table 5. Average level of hemoglobin for male subjects.

Hemoglobin level before the trip	**147.6g/L**
Hemoglobin level upon return	**152.7g/L**

Based on this result, we notice that hemoglobin level increased by 5,1 g/L.

In Table 6, the average level of erythrocytes in the male subjects of the experiment before and after the 10 day trip to Brezovica is expressed. The average level of erythrocytes for the male gender before and after the trip is calculated. Before the trip the value was $4,84 \times 10^{12}$/L while upon return the value was $5,22 \times 10^{12}$/L.

Table 6. *Average level of erythrocytes for male subjects*

Erythrocyte level before the trip	4.84×10^{12}/L
Erythrocyte level upon return	5.22×10^{12}/L

In similar way as in the previous two tables, in table 7 we have expressed the average value of hematocrit for male subjects. Before the trip to Brezovica the average level of hematocrit for the male subjects was 40,77% while upon return the level was 43,14%.

Table 7. *Average level of hematocrit of male subjects.*

Hematocrit level before the trip	40.77%
Hematocrit level upon return	43.14%

Based on this result we notice that the average hematocrit level has increased by 2,37%..

In table 8 we have expressed the increase in percentage of hemoglobin, erythrocytes and hematocrit for the male gender

Hemoglobin	3.44%
Erythrocytes	7.85%
Hematocrit	5.81%

While comparing the three parameters, the gained differences are analyzed in statistical manner and it's been concluded that the erythrocytes have encountered the bigger change out of the three tested parameters.

In table 9, the average levels of hemoglobin, erythrocytes and hematocrit for all the students are expressed (M & F).

Table 9.

Parametres	Before	After
Hemoglobin	143.19	148.04
Erythrocytes	4.7	5.0
Hematocrit	39.5	41.9

2.3. Verification of hypothesis

By the experiment carried in the sample of students of the faculty of Sports Sciences we fully confirm the verification of the main objectives while the verification of hypothesis set in the beginning of this study is possible in this manner:

H1: Hypothesis 1 is fully confirmed as important changes between the first and second measurements are confirmed

H2: Hypothesis 2 is not confirmed the way it was set out in the beginning because the changes noticed were not the same for both genders

3. Conclusion

With the research carried in this study we have noticed an increase in the average level of erythrocytes, hemoglobin and hematocrit even in shorter stays.

During the exercise in high altitude a stimulation of bone marrow can be noticed and increasing number of reticulocytes circulation which happens during the adaption of body organism in the new environment at this high altitude. This phenomenon was also confirmed with blood parameters tests upon return from the high altitude trip.

Based on many researchers it takes a minimum of 3 weeks stay at an altitude above 2000 meters in order to notice increase in erythrocytes, hemoglobin and hematocrit levels. Based on other authors in their studies we have noticed that in stays over 3 weeks in altitudes above 2000 meters erythrocytes have increased by 12,4% while with our research we have noticed that after a 10 day stay at an altitude above 2000 meters the level of erythrocytes has increased by 8,23% which is a significantly larger increase if compared to other studies because the students during this stay have engaged in sport activities.

1. Based on this research and discussions with other authors we have concluded that: during a 10 days stay of the students at an altitude above 2000 meters we have the following increase in blood parameters:
   - Number of erythrocytes (red blood cells)
   - Hemoglobin concentration(Hb)
   - Overall blood volume(HCT)

With our research we concluded that even with a shorter stay than three weeks the increase of these parameters (erythrocytes, hemoglobin and hematocrit) is possible with a considerable increase.

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The approach and the objective of this experiment are consistent with the determination of changes of blood parameters after the stay of the students at an altitude of 1800-2300 meters, for a ten-day long ski course. In this paper are included a total of 64 students of the Faculty of Sport Sciences in Prishtina, of the age group of 19-25 (the average age is 21). All students previously have undergone a medical check for TA, arterial pulse and respiratory rate.

In particular, the health situation is of subjects was examined, then, all students, at the same time, gave blood for analysis. In this experiment, three main hematologic parameters were taken in consideration: such as hemoglobin, hematocrit and red blood cells.

The same analyses were carried out after the 10-day stay at a high altitude. The results of the experiment have shown significant changes after the ten-day stay at high altitude, despite the previous results that show changes only after the twenty-day stay in such elevations.

Key words: *elevation, blood parameters, sports science students, high altitudes.*