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Effect of BEMER signal on biological restitution and cognitive processes after endurance exercise. A case study

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Summary

Capillary network density in particular tissues grows proportionally to their oxygen demand. BEMER therapy, used as complex or supplementary treatment, improves basic physiological processes, angiokinesis, microcirculation, as well as oxygenation and nutrition of muscle cells.

Material and methods. The study was conducted on a male individual who leads a healthy life style and who twice subjected himself to the markings of cognitive functions and selected blood indicators; first, during natural physiological restitution after endurance effort, and second, after restitution enhanced with BEMER therapy.

Results. Most significant changes after endurance effort were observed in the following blood indicators: leukocytes, erythrocytes, insulin and cortisol. Least significant changes were noted in the number of lymphocytes and in cognitive functions.

Conclusion.

1. Applied methodology and profile of BEMER signal, through increasing the lumen of microcirculation vessels, variously affects the value of selected blood indicators

2. The individual results achieved from the conducted measurements may not serve a basis for drawing generalized conclusions on after-endurance effect of BEMER signal; instead, they may be treated as an attempt at showing a direction for further research on the possible changes in the application method of the structurally multidimensional BEMER signal as well as on the intensification of biological restitution after various physical efforts.
3. More beneficial results of TMT test observed in the second course of measurements are rather a result of learning process than of BEMER therapy itself.

Key words: BEMER

Introduction

Microcirculation vessels constitute 99% of blood vessels[11] in an adult human body[1]. Circulatory system comprises of arterial vessels in 11,5%, of vein vessels in 14,5% of microvessels whose average diameter does not exceed 150 microns and in 74%[2]. Secondary arteries and veins, as well as capillaries, create the so called microcirculation which enables diffusion exchange of nutrients and metabolic by-products between blood and interstitial space surrounding the cells. Capillary network density in particular tissues grows proportionally to their oxygen demand. Thus, among organs characterized with most dense capillary network there are heart, brain, liver, kidneys and skeletal muscles. Diffusion surface area of particular tissues and organs depends not only on capillary network density but also on precapillary vessels functionality and their permeability. Precapillary vasospasm of the vessels with developed layer of smooth muscle tissue (sphincter) may result in significant or total blockage of blood flow through big microcirculation areas. Blood flows then through the so called arteriovenous anastomosis and thus omits diffusion areas. When precapillary sphincters are relaxed, blood flow in capillary vessels grows multiple times[3].

The main pillar of BEMER technology is its multidimensional signal structure which effectively stimulates reduced or distorted microcirculation. Bernat's research[4] on directed stimulation of poor circulation in internal organs and its effect on insufficient blood supply in microcirculation areas has indicated that only directed, biorhythmically defined signal may, to a significant extent, affect arterial vasomotor functions and microcirculatory regulation and thus it may be utilized as both preventive and complementary therapeutic measure. According to the manufacturer, BEMER system therapy, used as complex or supplementary treatment, improves basic physiological processes, angiokinesis, microcirculation, as well as oxygenation and nutrition of muscle tissues. Due to certain biorhythmic modulation it exerts synergic influence on primary and secondary, slightly bigger, blood vessels. It also affects the immune system, protein synthesis and production of endogenous antioxidants, ensuring at the same time improvement of our natural self-regulation mechanisms. In sleep mode, BEMER system intensifies blood redistribution and thus facilitates immunological processes, stimulates regenerative and restitute processes as well as more effective exertion of superfluous and acid substances with urine. Thus, it diminishes the risk of injuries and infections, positively affects anaerobic threshold, regenerative and healing processes, as well as effectiveness and intensity of training by enabling one to shorten breaks between exercises and thus better prepare oneself for competitions. BEMER therapy is also successfully used in MS (multiple sclerosis) treatment. No incidences of overdose or adjustment effect have been noted.[5]

Łyskawa[6] cites Lezak who, in turn, divides cognitive processes into their four dimensions: cognitive functions, executive functions, global functions, emotional and personality functions. Their disruptions, from mild to severe, may be diagnosed with wide plethora of tools. Among these, one may distinguish for example Wechsler Intelligence Scale, Raven's test, AVLT, CVLT or WCST. Their disorders have been studied by many researchers[7,8]. Executive functions are supreme mental processes, which constitute a link between stimuli and body reactions. Their role is to: delineate the aim of the action, control effective and deliberate mental activity, initiate reactions proportional to desired aims, maintain focus, change the object of focus or action scheme, enable abstract thinking and ability to predict the consequences of one's actions.[8]

Materials and methods

The aim of the case study is to determine the effectiveness of BEMER therapy and its effect on restitution and cognitive process after endurance exercise. The case study has been conducted on an adult man at the age of 61, 83,3 kg weight and 173 cm height. His BMI was 28,2, total adiposity 24,4 and inner adiposity 14, muscle percentage 34,1%. The measurements were obtained using Obron BF511 scale. The studied individual has a clean bill of health confirmed by a doctor, enabling him to undertake physical exercise at third intensity level. In terms of physical activity, he lives by ten commandments of healthy life style[10]. Before the case study, the consent of bioethical committee for invasive and functional research, as well as medical doctor's approval of subject's ability to take maximum level functional tests of cardiopulmonary system, were obtained. The following examinations have been conducted at Rehabilitation Centre of PODIMED Hospital in Szczecinek, thus securing the presence of a cardiologist, defibrillator, heart-attack rescue kit and proper hygienic conditions required for the collection of the research material. Blood, due to its highly sensitive structure, was drawn in a nearby PODIMED Hospital laboratory and immediately after handed over to the analysis. Preceding the examination, primary assessment of usability of the measured variables, calibration of the tools and the developed research procedure were also performed. Therapy facilitating restitution is not possible without diagnosis of subject's fatigue state and relax course. Their assessment may be conducted using variety of indicators, and their selection depends on the type and size of exercise load and technical possibilities of the researcher. The selection of blood indicators useful for the present case study was based on Łukaszewska's recommendations[11] and it involved cortisol, insulin, leukocytosis (WBC), neutrophils (NEU), lymphocytes (LYM), monocytes (MONO%), eosinophils (EOS), basophils (BASO), basophils percentage (BASO%), erythrocytes (RBC).

In order to ensure reliability of performed analysis of BEMER system, it was decided that the system will be the only element of biological restitution process. The method of system application was delineated based on manufacturer's recommendations and available publications, which establish sustained effects of therapy at 12 to 16 hours[12,13,14]. It was decided that during the second phase of the study BEMER therapy will be applied daily, seven days before endurance exercise, three times a day from 6.00 am to 6.08 am, from 4.00 pm to 4.08 pm, and in sleep mode from 10.00 pm to 5.30 am. Signal parameters in day mode were as follows: 6.00 am, stimulus intensity 10 (35 microtesla), 4.00 pm, intensity 6 (21 microtesla); in the night mode S2 from 10:00 pm to 5:30 am (10 microtesla). Activity area of the emitted signal covered the whole surface of the body, both lying on the back, as well as on the left and right side.

Drawing of blood and performed measurements were orchestrated according to the established program, always at the same time of day, so as to avoid changes of physical efficiency resultant from daily biological rhythm; they included pulse, systolic and diastolic pressure as well as selected blood features. Blood was always drawn from ulnar artery or radial artery of the right or left upper limb, while fore-arm and arm muscles were completely relaxed. The effect of physical exercise and BEMER system on psychomotor speed (part A of the test), operating visual-spatial memory and ability to switch from one category to another (part B) were measured with Trail Marking Test (TMT). TMT requires proper visual-motor coordination and it is based on the subject's ability to connect a set of dots marked with subsequent numbers and letters as fast as possible, while maintaining accuracy. Psychomotor speed equals the time in seconds achieved by the subject in part A and B of the test, as well as the difference between B and A[6].

Standard physical exercise was defined as high-intensity work. Its definition was based on Ulatowski's assumption[15] that high-intensity work should evoke systolic pressure within the range of 130-180 mm Hg while Brown indicator should be below 50. Applied endurance exercise lasted for 66 minutes and comprised of two immediate phases. The first phase entailed the following exercise loads: 2 minutes: 20 W, 4 minutes: 40 W, 2 minutes: 20 W, 4 minutes: 60 W, 2 minutes 20 W, 5 minutes: 80 W, 2 minutes: 20 W, 4 minutes 60 W, 2 minutes 20 W, 4 minutes 40 W and 2 minutes 20W. The number of spins was measured on cycloergometer equipped with electronic measuring system and it ranged from 60 to 70 rotations per minute. For the last 15 seconds of the second cycle, the subject stayed on ergometre and was advised to exercise freely without any load, which was to prevent circulatory collapse. Electrodes of cardio monitor and the sleeve of blood pressure meter were put on in the last minute of standard load exercise.

Research material was collected in order to normalize studied features and according to the following scheme:

1. Before exercise at 9.30 am and 10.30 am: blood indicators, cognitive functions test – TMT, atmospheric pressure, body temperature;
2. After exercise from 11.36 am.

Early restitution period

a) blood features at 11.36 am, 12.30 pm, 1:30 pm, 3.30 pm;

a) b. TMT test at 10.55 am;
b) c. body temperature.

Late restitution period

a) blood features for five consecutive days always at 8.00 am;
a. b. TMT test at 8.30 am in day one after standard load.

Statistical analysis

Due to the fact that the present case study was conducted on a single individual the applied statistical methods embraced the following: the calculation of average systolic pressure, diastolic pressure, and the differences between blood indicators obtained in the first and second phase of the study.

Results

Atmospheric pressure during the first phase of the study ranged from 719,8 mmHg to 732 mmHg, during the second phase from 746, 5 mmHg to 755,1 mmHg. Body temperature always oscillated within the range from 36,6 to 37 degrees Celsius. In the first phase of the study, systolic blood pressure ranged from 121 to 123 mmHg before physical exercise and decreased from 142 to 112 after physical exercise. Diastolic pressure ranged respectively from 79 to 80 mmHg and from 121 to 86 mmHg. In the second phase, before exercise it ranged from 118 to 119 mmHg, and then decreased from 137 to 111 after exercise. Average blood pressure ranged from 75 to 77 mmHg and from 98 to 76 mmHg. Average systolic and diastolic pressure ranged from 131 to 99 mmHg in first phase of the study, and from 117 to 94 mmHg in the second phase of the study. In the first phase, blood oxygen saturation before the exercise ranged from 94% to 95%, and after standard load from 92% to 94%. In the second phase, it was from 95% to 96%, and from 93% to 97%. In the first phase, pulse before exercise was 67 beats per minute and after standard load exercise it decreased from 109 to 77bpm. In the second phase of the study, it was from 105 to 66bpm.

In the first phase of the study cortisol value in blood serum stayed at similar level for the hour after finished work, then for the next 3 hours it grew rapidly, and for the next 53 hours it stayed steady, assuming values significantly greater from the initial number. In the second phase of the study, cortisol increased significantly for 1 hour after finished work, then it dropped in the next hour, and through the next 19 hours it increased, so as to stay steady in the next 36 hours, assuming values significantly greater than the initial value, table 1. Insulin measured after finished work in both phases of the study was distributed proportionally for the next 21 hours, though in the second hour one noted its rapid increase, which in the first phase was even greater than in the second. In the first phase, insulin value through the next 36 hours decreased, in the second phase it dropped, getting close to its initial value. After 57 hours, its value in the first phase was greater than its initial value, table 1. WBC value in blood after finished work in both phases was distributed similarly for the next 57 hours, though in the third hour of the first phase WBC was significantly higher than in the first hour, and in the sixth hour insignificantly smaller than in the first hour. After 57 hours its value in both phases of the study was smaller than its initial value, table 2. A number of neutrophils in blood in both phases of the study was distributed similarly in the next 57 hours after finished work, though in the third hour of the first phase it was insignificantly higher than in the first hour. After 57 hours, its value in both phases of the study was smaller in relation to its initial value, table 2. Number of lymphocytes in blood after finished work in both phases of the study was distributed proportionally for the next 57 hours, though before physical exercise it assumed insignificantly higher value than in the first hour, and in the sixth hour insignificantly smaller value. After 57 hours, its value in both phases was smaller than the initial value, table 2. MONO number in the first phase grew for the first four hours, and later it dropped to reach the value lower than its initial number. Measurements conducted in the second phase showed their smaller number after finished work. In the next 21 hours after finished work, MONO number grew and then it dropped in the next 36 hours. After 57 hours, its value in both phases was greater than the initial value, table 3. After the end of endurance exercise, MONO percentage in the first phase of the study dropped from its initial value until the end of the first hour.

In the early and initial late restitution period, namely 20 hours after finished exercise, its percentage increased, and in the next 36 hours it decreased, assuming values close to its initial value. In the second phase of measurements, the percentage distribution was similar and the biggest drop in value takes place during rest period. In the next 21 hours, there was a significant percentage growth, and in the next 36 hours it dropped to reach its initial value, table 4. EOS number in the first phase of measurements grew for the first 2 hours, and in the next 55 hours successively decreased to reach the value smaller than its initial number. In the second phase of the study, EOS number successively grew from the end of work for the next 57 hours, assuming values greater than its initial number, table 5. BASO number in blood in the first phase dropped from the beginning of the exercise until the end of the second hour after its end, in the next two hours it grew, and then dropped for the next 36 hours reaching value smaller than the initial one. In the second phase of measurements, the values were smaller until the end of exercise, and in the next 45 hours they dropped to reach their initial value, table 6. BASO percentage in the first phase and the first hour of early restitution increased, and then decreased, only to grow for the next 55 hours, ultimately reaching a number higher than its initial value. In the second phase, the percentage grows for the next 57 hours after the finished work, assuming value greater than the initial, table 7. RBC number in both phases is distributed similarly for the first hour after finished exercise. The values form the second examination round, however, are smaller than from the first. In the last 24 hours of restitution, the values from the second examination are higher than those from the first. While RBC number is close to the number from before the exercise, in the second phase it assumes lower value, table 8. Results indicate also that the values of cognitive functions in both phases of the study are very similar, table 9.

Discussion of results and conclusions

During long-lasting high-intensity endurance one observes a cortisol increase in blood. Hypoglycemia, hypoinsulinaemia, raise in body temperature and emotions enhance the production of this hormone. After submaximum physical effort, cortisol concentration in blood increases at the time of restitution, several minutes after finished exercise. Workout does not affect the concentration of cortisol in blood during rest period. According to most studies, cortisol raise in people who train is lower than in those who do not. Additionally, long-lasting endurance exercise increases cortisol concentration in blood similarly in young and older people[16]. From the conducted measurements, one may deduce that cortisol decreased in the first phase of the study at early restitution period after finished standard exercise load and in the second phase its distribution in time was in agreement with the above stated opinion. One may thus infer that BEMER therapy, through increasing the production of cortisol during early restitution, positively affected gluconeogenesis, preventing or delaying the onset of hypoglycemia. Higher cortisol, through lipases, increases lipoic effect of catheolamines in adipose tissue. Thus, it contributes to the growth of nonesterified fatty acids in blood.

Wright and Malasis research[17] indicated that muscle work may take place without insulin. Authors claim that catheolamines produced in increased numbers during physical workout may inhibit insulin production and, at the same time, cause the mobilization of glucose from the liver and fatty acids from adipose tissue. Intensified physical endurance leads to the exhaustion of carbohydrates energy sources and to gradual growth in fat metabolism. Extensive physical effort might result in hypoglycemia and ketone bodies in blood and urine[18]. Physical effort and training increase insulin sensitivity in young and older people[16]. The conducted measurements point out that insulin level during physical endurance in the first phase of the study is higher than in the second, which may be the result of the applied BEMER therapy; during early restitution period in the second phase of the study its value is higher than in the first phase. It is significant to note that at the beginning of late restitution period in both phases of the study insulin levels are almost identical. Furthermore, its distribution suggests that in the second phase, when BEMER therapy was applied, energy from glucoses and adiposity acids at the early restitution phase was less intensively rebuilt as contrary to the late period.

Lubańska-Tomaszewska[19] claims that in rats intense physical endurance causes phase changes in leukocyte numbers in circulatory blood. In the first phase, one notes their increase resultant from activation of bone marrow, thymus and lymphatic nodes. The second phase characterizes itself with a drop in leukocyte stemming from their intensive decomposition, which, in turn, is a result of metabolites activity. Physical workout, according to the author, causes lymphocytosis and granulocytopaenia. Under the effect of exhausting physical exercise, she observed an increase of mezoblasts, promyelocyte, neutrophil myelocytes and segmented neutrophil granulocytes in bone marrow. Changes in white cell system after workout entail an increase in the number of myeloblasts, promyelocytes, segmented granulocytes and neutrophilic granulocytes, as well as segmented and neutrophilic granulocytes, segmented eosinophilic granulocytes combined with simultaneous drop in the number of neutrophilic myelocytes, eosinophilic myelocytes, neutrophilic metamyelocytes, banded neutrophilc and segmented basophilic granulocytes.

Mc David[20] studied the effects of continuous and interval training on the number of leukocytes in capillary blood. He determined that their increase after endurance is proportional to workout time and intensity. Workout type, however, did not exert any significant effect on after-effort leukocytosis. Patriarca and Topi[21], in turn, indicate that during exercise on cyclometer loaded with 120kgm and continued until exhaustion the level of lymphocytes increases and, after finished exercise, it drops below the initial level. Similar changes were observed in neutrophils. Eosinophil number decreased gradually after physical effort and it reached its lowest number in the minute 30, coming back to its initial level in the 90th minute after finished workout. Changes in leukocytosis, neutrophils and eosinophils observed during the study are in agreement with other authors' research.

In the second phase of the study, however, leukocytosis lasted from the 4th hour of early restitution, in the first it begun earlier and lasted from early to late restitution period. In the second phase of the study eosinophils distribution in time did not show the above mentioned variability. One may thus assume that it is a positive result of BEMER signal. Therapy applied in the second phase did not exert any significant effect on lymphocytes. Monocytes consist 3-8% of all leukocytes in blood and they are precursors of mononuclear macrophage system cells[22]; they stay in blood for 1-2 days and then they permeate into tissues, where they differentiate to macrophages. Monocytes show the ability of phagocytosis and of releasing substances regulating inflammatory processes[23] into blood. Dziedzic[24] indicated an increase in gamma-globule fraction and monocytes number after eight-hour work, accompanied by simultaneous drop in lymphocytes.

Values distribution in time, as well as monocytes percentage observed from the beginning to the end of exercise with standard load, remained at low level what stands in agreement with other authors' claims. Then, one observed a rise in their phagocytosis and anti-inflammation activity, occurring most probably in the muscle system. In the second phase of the study, increased monocytes activity appeared after finished work in the early phase of restitution, and it lasted until the late phase of restitution, while in the first phase it was an hour from the finished exercise. Basophiles constitute up to 1% of all leukocytes and around 2% of all granulocytes[22]. Basophiles distribution in time and their percentage observed from the beginning until the end of exercise with standard load was at low level what stands in agreement with other authors' claims. Then, one noted an increase in their phagocytosis activity. In the second phase of the study, increased basophiles activity occurred after finished work, at an early phase of restitution, and it lasted until its end; in the first phase of the study this particular moment, an hour after finished work, was characterized with the lowest basophile number. Basophilia in the second phase of the study also started at the end of workout and it lasted until the late restitution period. In the first phase, its lowest number was noted half-way through the process of early restitution, after which its number was only growing. One may thus claim, though with caution, that applied BEMER therapy normalized and facilitated monocyte and basophile phagocytosis in both periods of restitution.

One of the results of physical endurance in humans is the change in the number of red blood cells in circulatory blood. Character of those changes depends on many factors and data provided by various authors are oftentimes contradictory. Discussing shifts in erythrocytes number, one must remember that they directly depend on the intensity of erythropoiesis and the mechanisms of blood cell loss[18].

De Lanne[25] showed after-exercise growth of hemoglobin and in hematocrit. He claims also that hard and long-lasting physical effort decreases erythrocytes number and hemoglobin concentration. Patriarcha and Topi[21], in turn, declare that after finished cyclometer workout continued until exhaustion (load: 1250 kgm/mm and time:14-45 minutes) hematocrit increased during physical effort but, after its end, it quickly came back to its initial level. Erythrocytes number decreased in a statistically insignificant way and hemoglobin dropped after exercise, and then grew during rest. According to Lubańska-Tomaszewska[19], after-workout changes leading to drop in erythrocytes may be the result of disintegrating red blood cells, storing erythrocytes in spleen and muscles, as well an increasing level of circulatory blood.

Measured erythrocytes decomposition in time stays in agreement with other authors' claims. Smaller erythrocytes numbers noted in the second phase of the study are the result of shifts in erythrocytes and in hemoglobin levels, which, as one may deduce, depend on physicochemical changes in blood plasma and in red blood cells triggered by physical effort. One may thus claim, though with caution, that these smaller erythrocyte values in peripheral vessels captured during the second phase of the study are the result of better drainage of microcirculatory vessels perfected by BEMER signal. This, in turn, may result in better nutrition and disposal of by-products from tissues engaged in workout. In source literature, there are no studies on cognitive processes distortion and execution stemming from physical effort. Better TMT test results noted in the second phase of the study are attributed to the learning process rather than to the effects of BEMER therapy.

Conclusions

1. Applied methodology and profile of BEMER signal, through increasing the lumen of microcirculation vessels, variously affects the value of selected blood indicators
2. The individual results achieved from the conducted measurements may not serve a basis for drawing generalized conclusions on after-endurance effect of BEMER signal; instead, they may be treated as an attempt at showing a direction for further research on the possible changes in the application method of the structurally multidimensional BEMER signal as well as on the intensification of biological restitution after various physical efforts.
3. More beneficial results of TMT test observed in the second course of measurements are rather a result of learning process than of BEMER therapy itself.

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Table I. Cortisol level in blood serum and insulin level in blood before and after standard load exercise in the first and the second phase of the study (n) 1

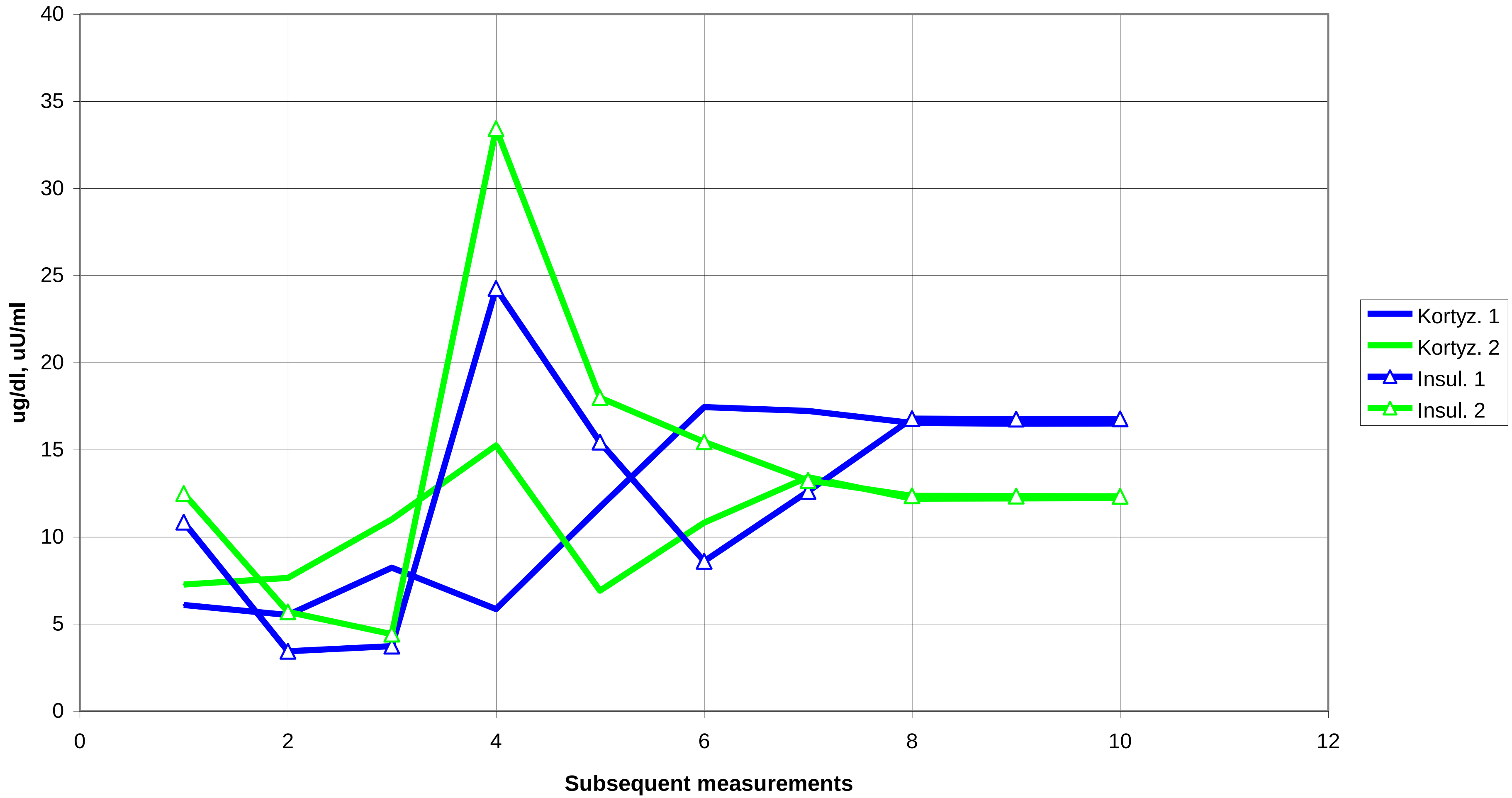

Table II. WBC, NEU, LYM level in blood before and after standard load exercise in the first and the second phase of the study n (1)

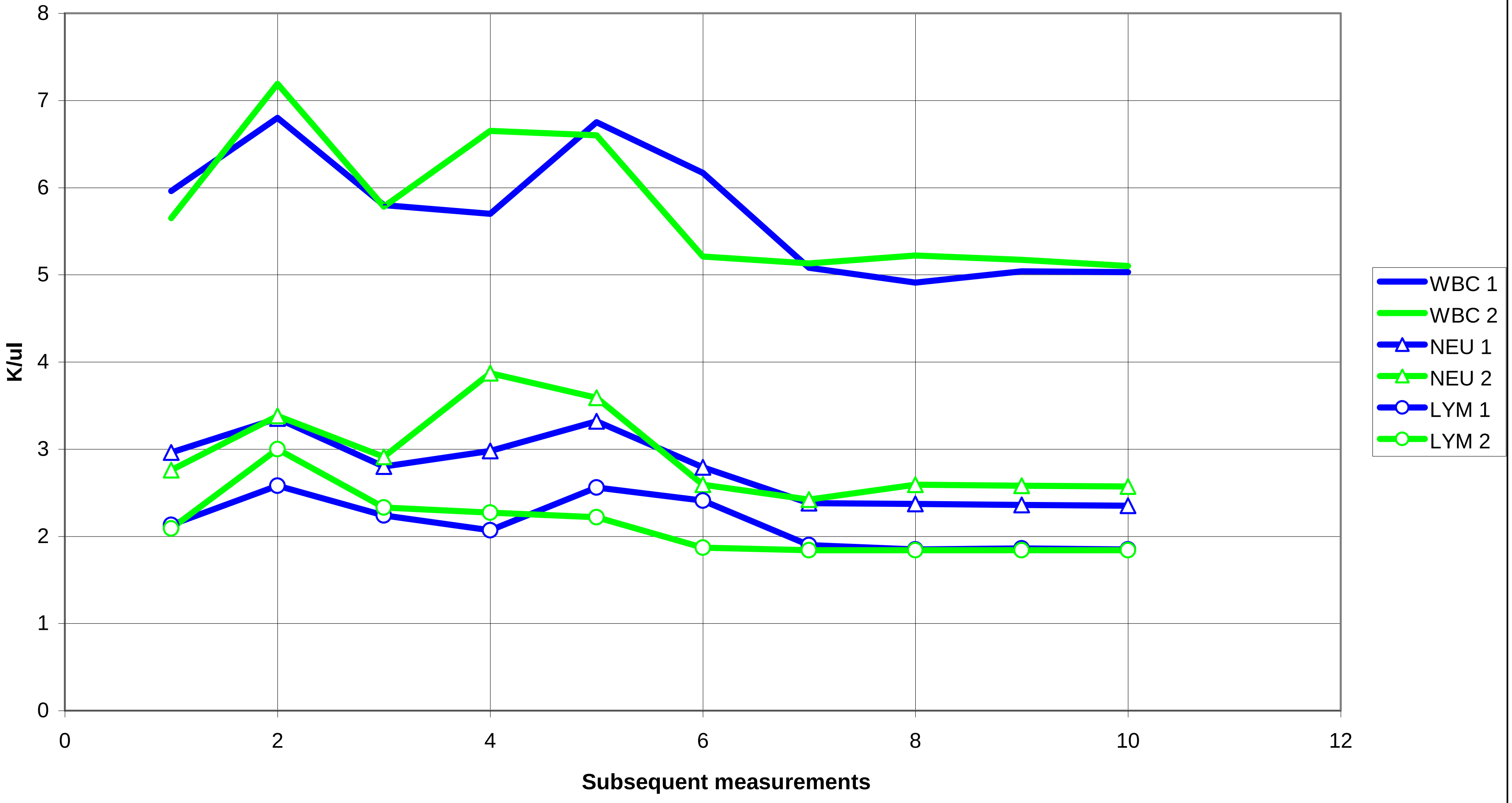

Table III. MONO level in blood before and after standard load exercise in the first and second phase of the study (n) 1

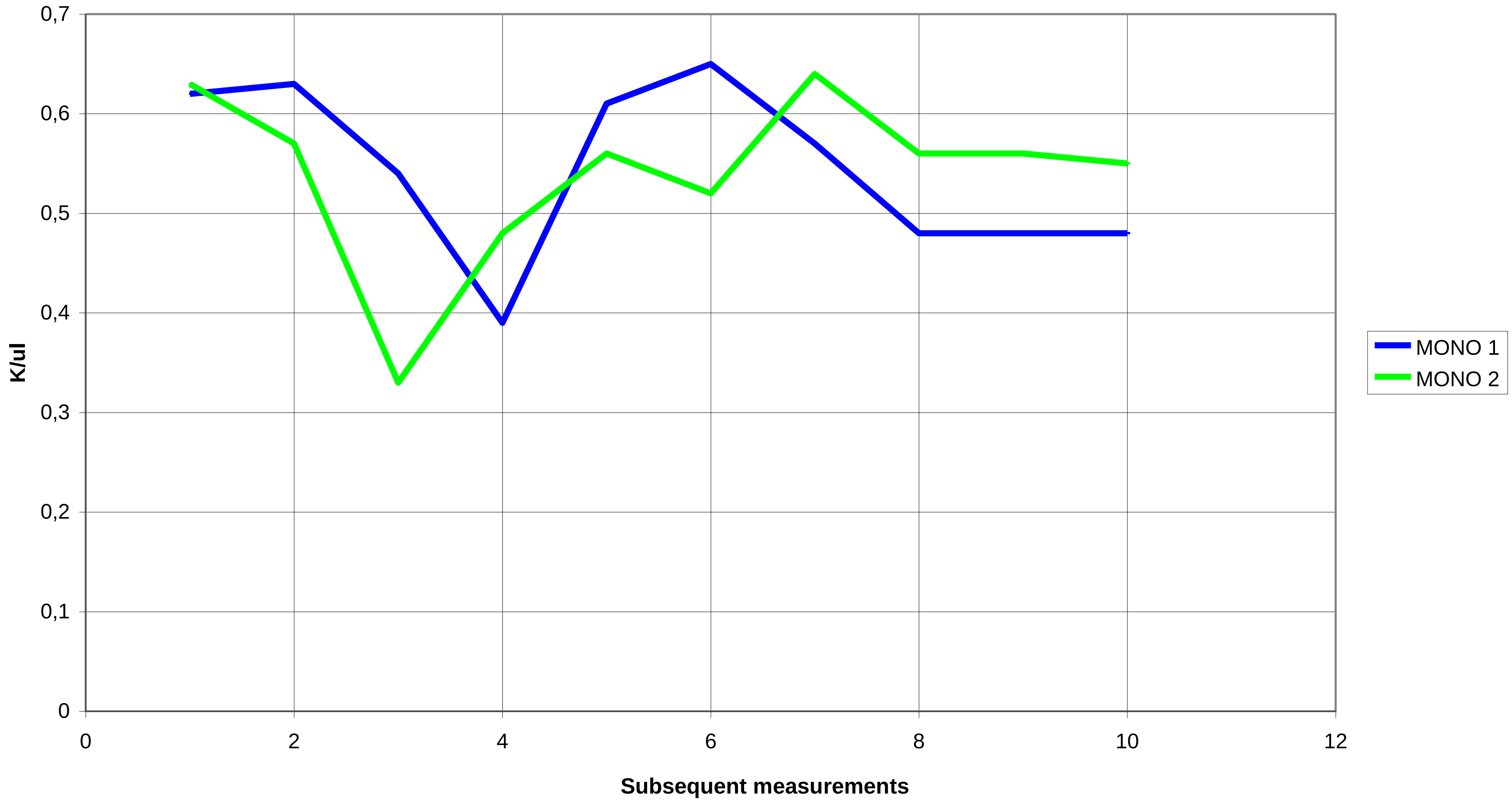

Table IV. MONO percentage in blood before and after standard load exercise in the first and second phase of the study (n) 1

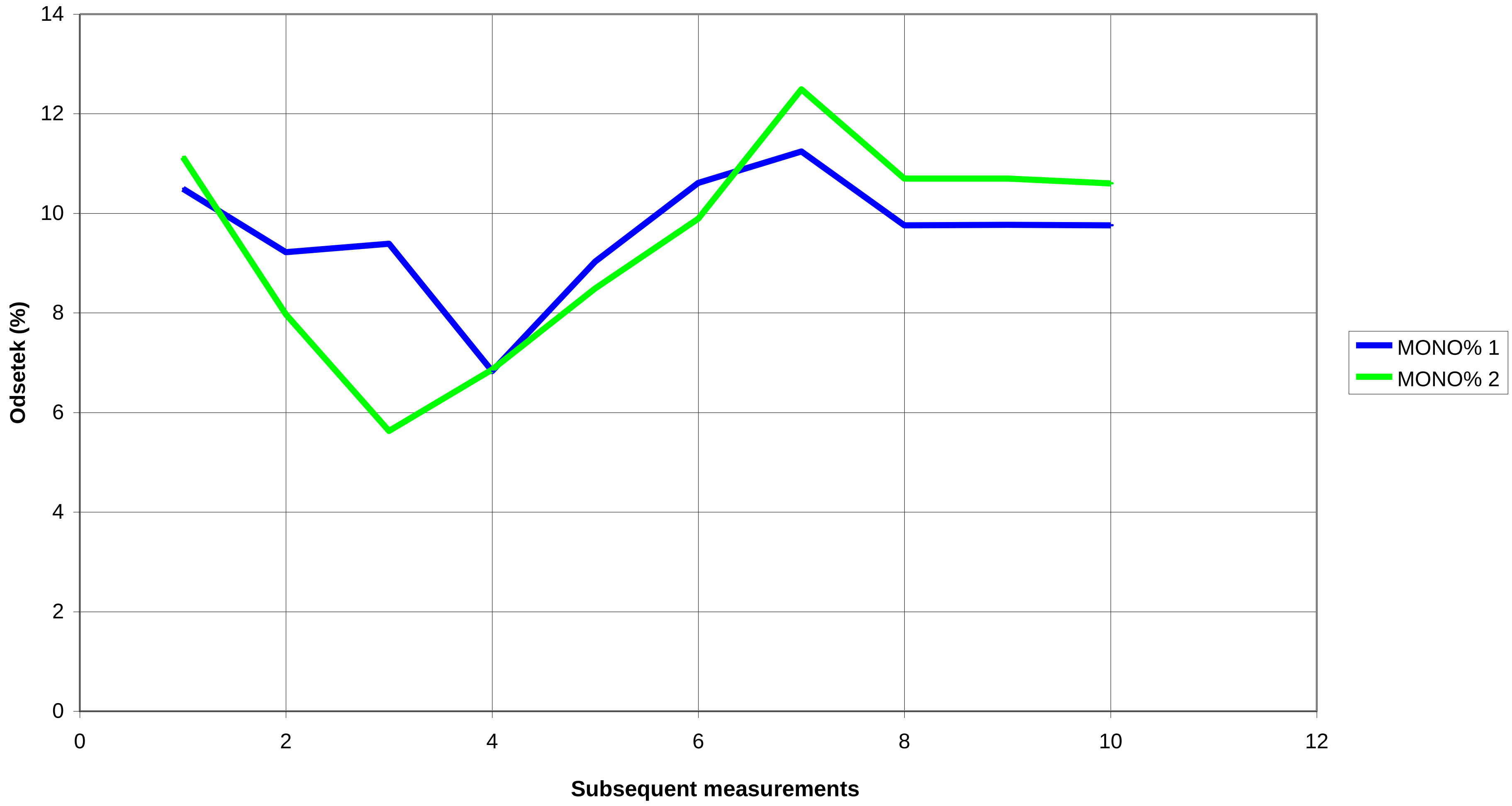

Table V. EOS level in blood before and after standard load exercise in the first and the second phase of the study (n) 1

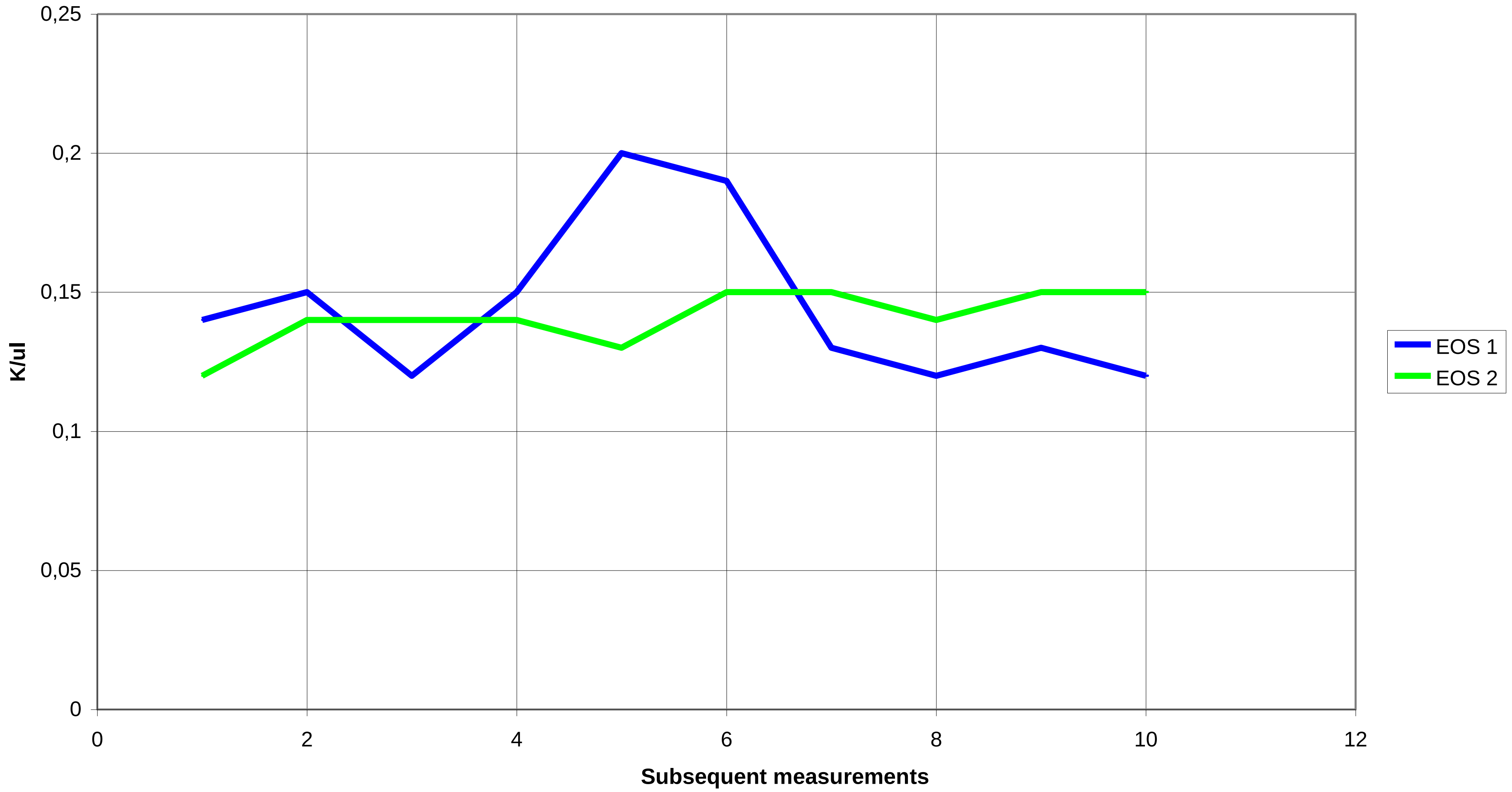

Table VI. BASO level in blood before and after standard load exercise in the first and the second phase of the study (n) 1

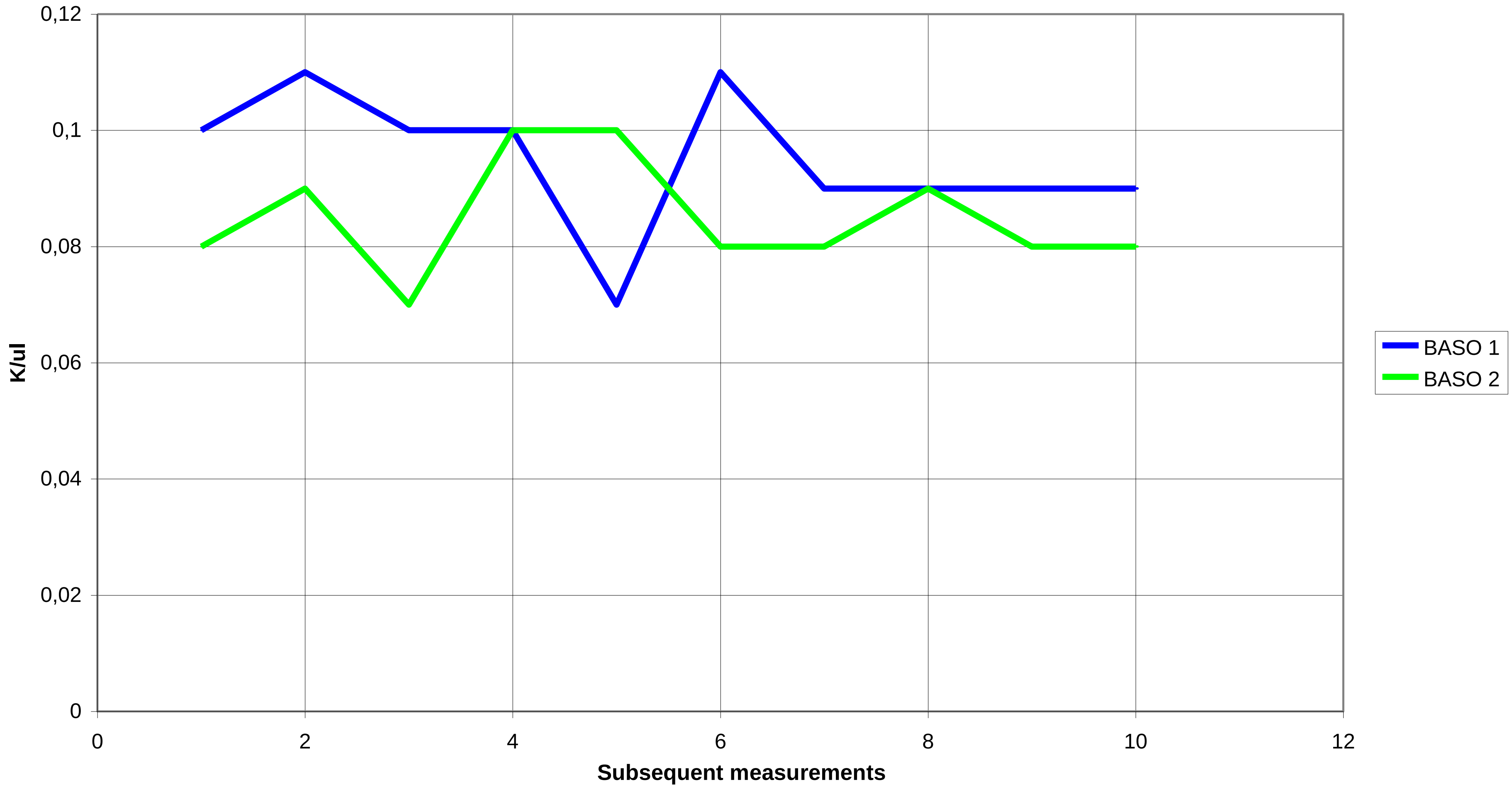

Table VII. BASO percentage in blood before and after standard load exercise in the first and the second phase of the study (n) 1

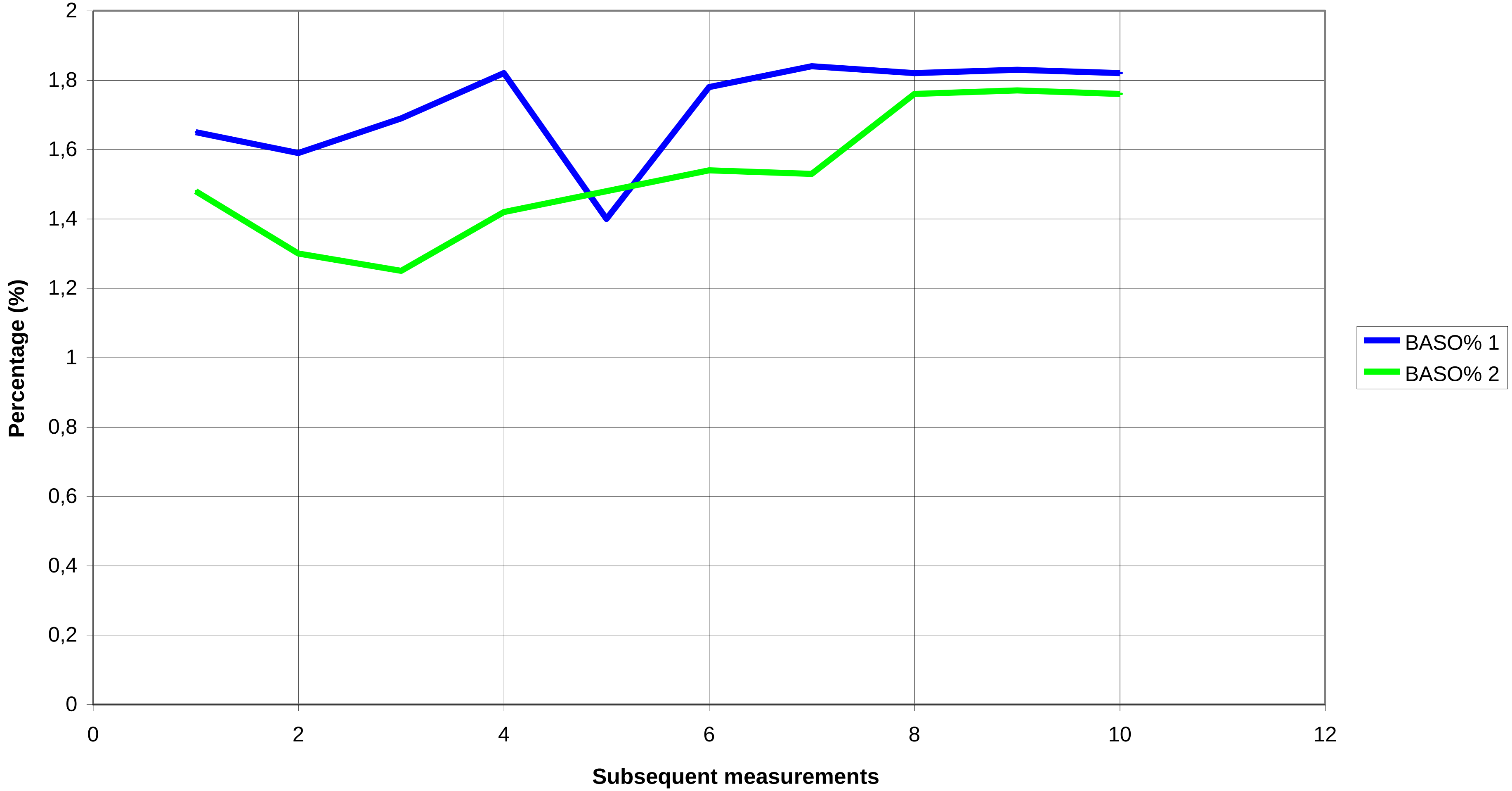

Table VIII. RBC level in blood before and after standard load exercise in the first and the second phase of the study (n) 1

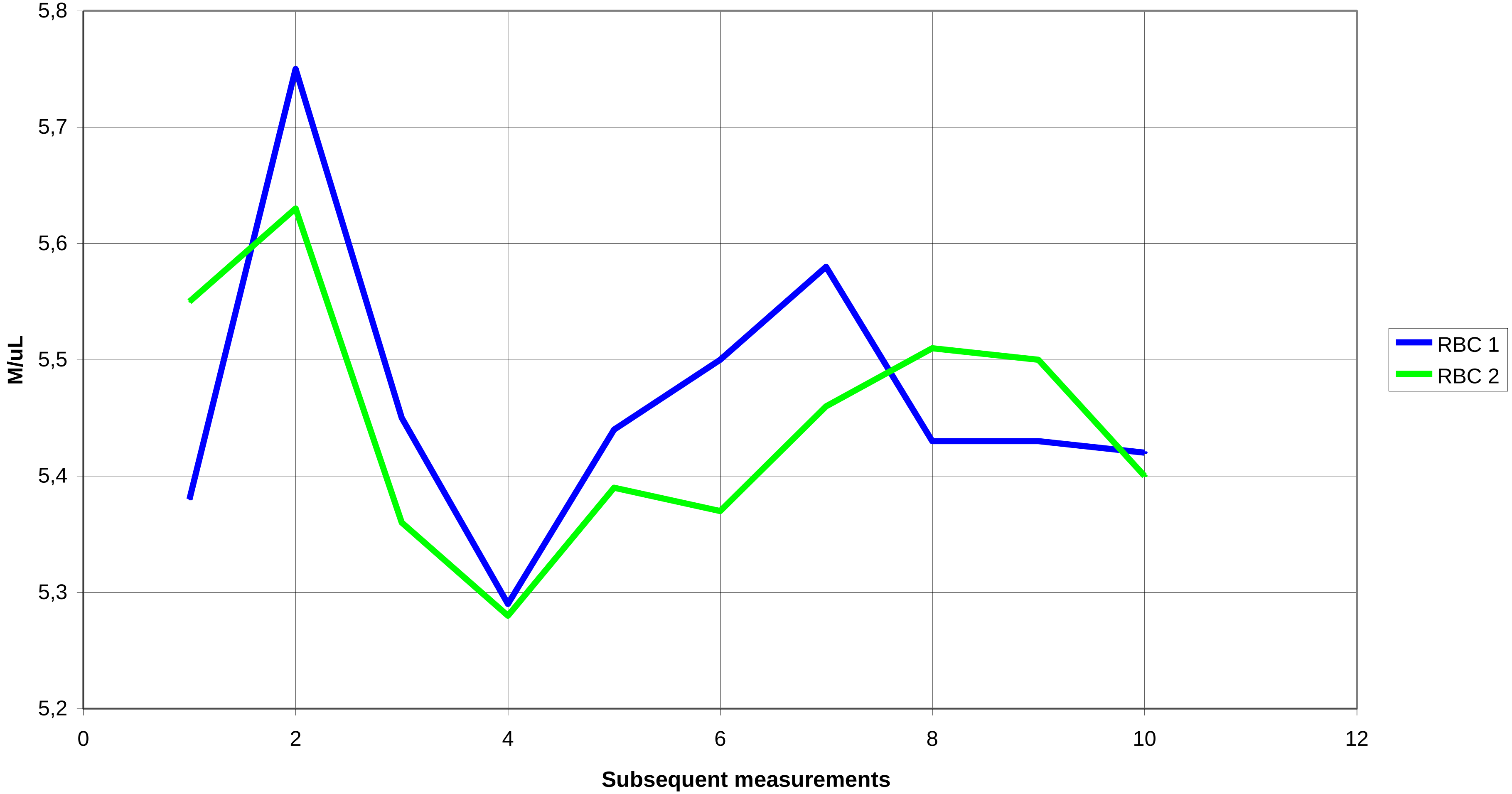

Table IX. Cognitive functions restitution before and after standard load exercise in the first and the second phase of the study (n) 1