

Original Article

**Analysis of biochemical indicators of disabled athletes  
in dynamics of physical therapy programs**

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**Abstract.** The analysis of ways to optimize the training of athletes with disabilities has been carried out. It has been ascertained that locomotor activity helps to restore fitness shape, promotes development and refinement of physical, mental, functional and volitional skills, facilitates integration of the disabled athletes into the society. Expediency of special exercises, remedial massage modalities as well as hydrotherapeutic procedures for athletes with disabilities has been substantiated.

The effect of various individual programs, means and modalities of physical rehabilitation on the biochemical indices of athletes with disabilities of different nosological forms of diseases has been analyzed. Algorithm tools and physical therapy methodology of individual programs for disabled athletes have been elaborated. The effect of physical therapy means upon biochemical indices of disabled athletes with various disease entities has been analyzed. It has been found that potassium, calcium and phosphorus indicators in capillary blood; creatinine and creatine phosphokinase in venous blood; COP-17 content in urine at the beginning and at the end of the experiment (background indicators, after exercise and after individual physical therapy programs) were within the normal range for certain age group.

**Key words:** biochemistry, individual programs, indices, athletes with disabilities, exercise, physical therapy.

**Introduction.**

Physical education is the major stimulus for physical culture development and implementation, thus becoming an integral part of general all-round education, which has to ensure the development of physical, moral, volitional, intellectual qualities of all strata of the population [1, 2]. Constant and continuous monitoring of training sessions and physical therapy procedures for disabled athletes made it possible to monitor their biochemical indicators. It has been scientifically proven that physical therapy means and modalities have a positive effect upon metabolic processes due to activation of gas exchange in tissues, thus accelerating lactic acid excretion from the body, as well as nitrogenous substances and excess fluid from the muscles [3, 4, 5].

From this standpoint the study of the dynamics of change in such biochemical indicators like potassium, calcium and phosphorus quantity in capillary blood; creatinine and creatine phosphokinase in venous blood; COP-17 content in urine seem to be informative enough. Regulatory mechanisms in disabled athletes are in a permanent state of tension, thus providing an adequate functioning of the body vital activities [4, 5]. Motor impairments cause dysfunctions of gastrointestinal tract and urinary system; muscle atrophy and joints contraction might usually occur [6]. The studies of A.I.Kravchenko and V.I. Honcharenko (2008) in particular are devoted to the problems of work rate rehabilitation in football players with disabilities by means of acupuncture. The role of physical training and sports in physical rehabilitation that improve disabled athletes' standards of living is presented in the research of V.V. Khramov (2008, 2010). R.Y. Rudenko (2010 – 2014) has carried out a number of the research on the effect of physical therapy modalities upon physiological condition of athletes with disabilities. The issues of rehabilitation of disabled swimmers by means of heat modalities applied to their tensed muscles and the improvement of their body conditioning due to hydrotherapy were studied by T. Prystupa (2014). It has been found that according to the study results rehabilitation process obtains its specific characteristics that depend upon age, sex, and sports qualification, as well as basic and concomitant diseases. All mentioned factors have been taken into account while elaborating individual physical therapy programs [7].

**Material and methods.**

Organization of the research. The study was carried out at the training centers of National Teams of Ukraine. The study involved 112 qualified athletes with disabilities (N = 112: 56 persons – Control Group (CG) and 56 athletes – Main Group (MG)) belonging to different nosological groups and possessing various forms of diseases (Ethics Committee of the Lviv National Medical University named after Danylo Halytskii, minutes No 2 of February 16, 2015). MG disabled athletes trained according to the authoring individually suited physical

therapy programs, whereas the CG athletes trained according to conventional methods recommended by medical training centers. The studies lasted for 10 months.

Methods of research. Biochemical analysis for monitoring of potassium, calcium and phosphorus indicators in the capillary blood; creatinine and creatine phosphokinase in venous blood; COP-17 content in urine: background indicators (at rest), after exercise, at the beginning and at the end of the studies. Statistical data were obtained by means of descriptive statistics with the help of Microsoft Excel for Windows, SPSS 10 for Windows, Statistica 6.0. software packages.

**Objective of the research:** to analyse the effect of physical rehabilitation upon biochemical indicators of disabled athletes with various nosological forms of diseases.

**The research results.** Elaboration of individual physical therapy programs for disabled athletes is a specific task. Individual differentiation is a strategy for the process of physical rehabilitation of athletes with disabilities. Individual physical rehabilitation program considers the course of the main and concomitant diseases, observes the principles of harmonious exploitation alongside with rational regulations for physical rehabilitation application according to the criteria for the effectiveness of physical therapy (Fig. 1).

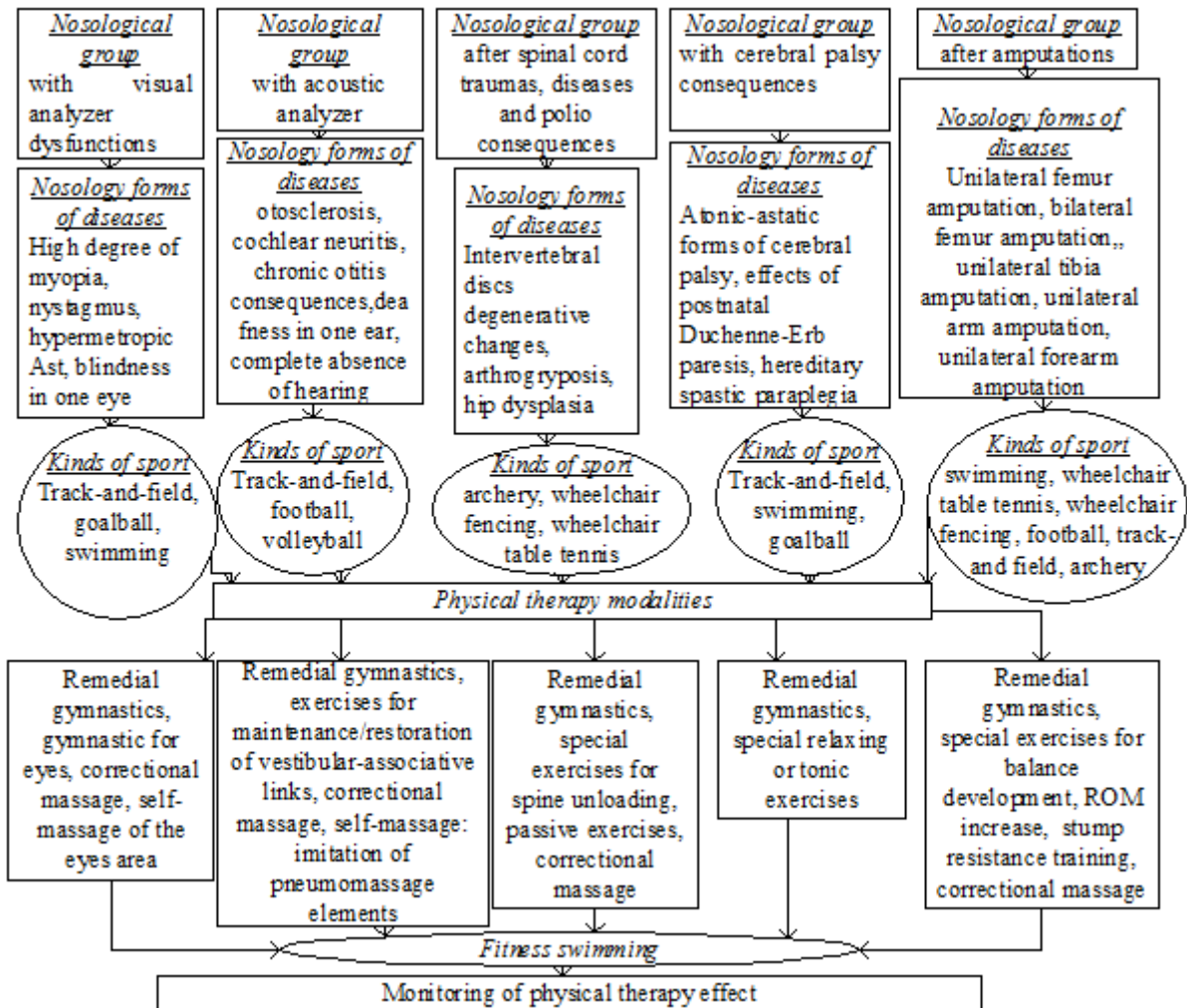


Fig. 1. Algorithm of physical therapy individual programs for disabled athletes

It has to combine both general and special effect upon the body. Special training has to develop those functions, which were affected by primary or satellite pathology; it has to restore and improve motor activities and skills necessary for execution of standard movements. It is also important to consider significant adverse changes in the functional state and the way athletes feel as a result of violation of adaptive processes caused by physical activity during exercise. Exercising is accompanied by the release of minerals from tissues to blood, their redistribution among tissues, as well as their increased excretion from the body through sweat and urine, especially those of potassium and sodium. Inadequate mineral content in the body causes a decrease in physical performance and sometimes to emergence of diseases or aggravation of the existing pathologies [8].

Potassium in the blood of the disabled athletes with amputations in both groups at rest at the beginning of the study was the same. After physical activities (PhA) the content of these macroelements increases in the main group (n=10) by 30 percent whereas in the control group (n=10) the growth was by 22.5 percent (P<0,05). By the end of the study, after exercising the indices grow, whereupon percentage increase is lower as compared with the beginning of the study, as well as the indices of the CG. As for calcium, the indices of this macroelement at rest at the beginning of the study were somewhat higher in the blood of MG persons in

comparison with the CG athletes. Significant differences in the content of calcium after exercise at the end and at the beginning of the study were not observed. At the beginning of the experiment the content of phosphorus in the MG athletes was slightly higher as compared to CG persons (32 percent). By the end of the study phosphorus content in the blood of MG disabled athletes with amputations at rest was lower in comparison with the beginning of the study by 30 percent ( $P < 0,05$ ). After exercise insignificant increase of this macroelement was observed in both groups. Reliable difference of potassium content in the blood of the disabled athletes with cerebral palsy after-effects at rest at the beginning and at the end of the study was not found. No reliable difference between groups was observed either.

The biggest differences in potassium dynamics in the disabled athletes with traumas, spinal cord diseases and polio consequences were observed between potassium content at rest and after exercise at the beginning of the experiment in MG athletes (36 percent) and in the CG athletes at the end of the study (48 percent). Potassium content difference at rest at the beginning of the study between the athletes of the CG and MG made 3 percent, while at the end of the experiment it was 5 percent. After exercising the calcium content increased in both groups. As for phosphorus these figures were insignificant.

The biggest growth of the potassium content in blood were observed in the MG athletes with dysfunctions of the auditory analyzer at rest and after exercise at the beginning of the experiment (by 25 percent) and in the CG athletes at the end of the experiment (by 23 percent). Calcium content in blood of the MG athletes at rest at the beginning of the study was 2.20 mmol/l and after exercise it was 2.25 mmol/l. At the end of the study the content of this macronutrient element in the MG athletes was 2.15 mmol/l and after exercise it increased to 2.30 mmol/l. The calcium content in the CG athletes at the beginning of the study at rest was 2.15 mmol/l and increased after exercise to 2.41 mmol/l. At the end of the experiment calcium content at rest in the CG athletes' blood was 2.20 mmol/l and increased after exercise up to 2.45 mmol/l. Thus more significant differences of this macronutrient element were observed in the CG athletes. Phosphorus content at the beginning of the experiment was slightly higher in the MG athletes. This index did not differ significantly at the beginning and by the end of the study. The difference in potassium content in the blood of the disabled athletes with the dysfunctions of visual analyzer in both CG and MG at the beginning and at the end of the study was not relevant. Calcium content in the blood of both these groups participants at rest was 2.12 mmol/l and increased after exercise by 25 percent. Phosphorus content at the beginning of the study in the MG athletes was somewhat higher as compared with the CG athletes. After exercise the phosphorus content increased in both the MG and the CG by 7 and 2 percent correspondingly.

Vigorous exercise causes an increase of creatinine in blood. Thus the indices of creatinine in blood in the athletes with visual impairments at the beginning of the study after exercising increased by 5 percent in the MG and by 12 percent in the CG. By the end of the experiment creatinine in blood of the MG visually impaired athletes increased by 4 percent and in the CG – by 7 percent. Similar dynamics could be observed in all the study groups. We found no significant differences in the content of creatinine in blood between the MG and the CG athletes neither at the beginning nor at the end of the study, as well as no relevant difference was observed among nosology forms of diseases. Creatine phosphokinase is an enzyme, which is a natural catalyst for chemical reactions that significantly increases the rate of ATP and ADP. This reaction proceeds at a high speed during intense muscle contractions. We found no significant changes of this factor either at the beginning or at the end of the study in all the study groups. The indices characterizing body's response to exercise is COP-17, which are the products of metabolism of androgens male sex hormones. The most significant indicators of COP-17 content in urine were found in the cerebral palsied athletes: after exercise this figure increases by 82 percent in the MG athletes at the beginning of the study and by 92 percent in the CG. At the end of the experiment COP-17 content indicator increases by 63 percent in the MG athletes and by 96 percent in the CG athletes. Similar dynamics could be observed in the group of athletes with disabilities after amputations.

## Discussion.

Top class athletes with disabilities are exposed to significant mental and physical stress that leads to a decrease in the level of efficiency and the occurrence of the disorders in the activity of certain bodily functions, organs, and systems [9]. It is impossible to achieve high results without appropriate balanced control over the functional training of athletes, who perform large volumes of work often to the detriments to their health [8].

The expediency of developing correctional and rehabilitative programs for athletes with disabilities aimed at the improvement of their sportsmanship has been scientifically proved (M. M. Lynets et al., 2002). Olena Kryvorutchenko et al. (2011, 2012) carried out a study of biochemical blood value parameters (hemoglobin, erythrocytes, urea, and lactate) in athletes, observing that metabolism level in the body was within the normal limits after a day of rest and by the end of each microcycle in all the examined athletes. Investigations of the functional state of top-class sportsmen with the help of biochemical control were carried out by O. A. Shynkaruk, O. M. Lysenko, L. M. Gunina and others (2009). Our research confirms the need for monitoring of blood and urine biochemical indices in qualified athletes with disabilities.

A number of scientists put sports activities for the disabled athletes on the same footing as rehabilitation [8, 10]. We consider this point of view to be controversial, although it has found its partial confirmation in the results of our research. It has turned out, that qualified athletes with disabilities experience aggravation of their

pathological condition that consequently resulted in disability because of inconsistencies in the intensity of physical activity and functional capabilities. After physical activity, changes of blood and urine biochemical indices are observed. The investigated parameters are informative enough, whereas sodium, chlorine and potassium are constant components of all cells and tissues, thus ensuring the continuity of the internal environment. Potassium and phosphorus are involved in maintaining the electrical activity of the brain, in functioning of the nervous tissue, as well as in contraction of skeletal and cardiac muscles. During strenuous training and competitive activity oscillation of this element might occur.

Disorders (changes) in functional activity of muscles are primarily reflected in the indices of creatine and creatinine in blood serum (plasma), and therefore their quantitative determination serves as a marker of muscles condition. Damage to muscle tissue, inadequate exercise stress, and malnutrition often give rise to increase of creatinine in blood. We assume that the range of physical exercise, application of physical rehabilitation procedures should correspond to functional capabilities of muscles energy supply in athletes with disabilities. Increase of creatinine level in blood is obviously connected with strenuous exercise activity, which demands increased muscle work energy supply. In our opinion, the study of creatine phosphokinase content is no less important a problem. This indicator, in particular, plays a significant role in the energy exchange of muscle, nervous and other tissues. Exercise activity can boost catalytic concentration of creatine phosphokinase in the blood plasma [4]. Since the isoenzymes of creatine phosphokinase are in the skeletal muscles, in myocardium and CNS, the creatine phosphokinase general activity testing is performed mainly for myopathy and myocardial infarction diagnosis, as well as for CNS activity reducing and diseases. Increased value of the enzyme activity could be observed after considerable physical exertion or vigorous competitive activity. Significant increase of creatine phosphokinase level testifies to inadequately high exercise stress, whereas the decrease of this index is peculiar to sedentary way of life and reduction in muscle mass in the long run.

Certain increase in COP-17 level of excretion may indicate the decline of the body protective functions. Estimation of COP-17 level of excretion in daily urine of athletes with disabilities while training sessions could be an indication of inadequate exercise exertion and emotional stress. Biochemical methods of research are informative indicators of physiological changes in the body under the action of loads of varying intensity that improves significantly the training process of qualified athletes with disabilities. Increase of these metabolites is a result of stress reaction of the body in response to exercise. However, the positive aspect is that by the end of the study the percentage increase in hormone concentration decreases.

Analysis of the research results indicates the expediency of elaborating individual physical rehabilitation programs alongside with monitoring biochemical indices of blood and urine. This will enable to adequately distribute physical activity, taking into account the basic pathology and will improve sports achievements of athletes with disabilities.

### Conclusions.

Algorithm of individual physical therapy programs for disabled athletes with various nosology forms of diseases has been elaborated; according to the results of biomechanical parameters of certain macronutrient elements a positive effect of individual physical therapy programs for disabled athletes and decrease of the body stress reaction in response to exercise could be observed.

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