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CHARACTERISTICS OF REHABILITATION OF PEOPLE WITH SPINAL CORD INJURY

ABSTRACT

The article shows the results of the study concerning the rehabilitation peculiarities of young people with cervical spinal cord injuries. The aim of the study is to develop the optimal rehabilitation program, motor development and motor compensation, physical characteristics, mental health, nerve and muscle function, and the formation of positive motivation during special training programs. It will help young people adapt to their new situation, and to integrate them into society.

The results of the experiment have shown quite a low level of development of motor skills, manual motor skills, daily living skills, and little regulation of the visceral motor system. The aim of the present work is to present correctional rehabilitation during three phases (early, late, and residual). 150 students, including 90 boys and 60 girls aged 16 to 18 with incomplete cervical spinal cord injuries participated in the study. It has been proven that the main psychological and pedagogical conditions, which fully ensure the effectiveness of psychophysical and social rehabilitation of elder students with incomplete cervical spinal cord injuries are: staged approach to rehabilitation that takes into account the complexity of this disease and personal characteristics, creating comfortable conditions and situations that form optimistic expectations about students' capabilities, and positive didactic rehabilitation motivation; a comprehensive approach to the correction using psychological and social factors, specific motor training, methods of control, motor skills formation, physical development, correction, and motor compensation; control of the level of fundamental motor skills; a comprehensive approach to social adaptation; and finally high physical activity level of each person with disabilities in official and independent types of physical therapy.

Specially organized training according to all the criteria and indicators, positively influenced the students from the experimental group in contrast to the control group, where the indicators remained quite low.

KEYWORDS

correction, rehabilitation, spinal cord injury, physical development.

INTRODUCTION

The problem of helping persons with disabilities is one of the most important and relevant in the social policy of any state. One of the principles of forming this policy is the concept of disabled people's independent living, which reduces the social burden on the state and society, serves as a source of replenishment of labor resources, and contributes to improving the life quality of this group of citizens. The basis of policy concerning disabled people is their rehabilitation, which allows them to achieve and maintain an optimal level of independent life. Rehabilitation, therefore, is a process that aims to help disabled people achieve an optimal physical, intellectual, mental, and social standard of living, providing them with the means of changing their lives and broadening their independence (Nestorenko et al, 2017; Nestorenko et al, 2018; Polishchuk et al., 2022). This also applies to the correction and rehabilitation of persons with musculoskeletal system injuries, because this problem has always been quite acute and attracted the attention of such specialists of the appropriate institutions as doctors, teachers, psychologists, rehabilitologists, defectologists, etc.

There were 2.6 million disabled people in Ukraine in 2017 (more than 6% of the country's population), at the same time, the number of people with special needs increases annually by 200-250 thousand people. Spinal and spinal cord injury is a severe defect that results in Group I or Group II of disability in 90% of the cases. The rehabilitation of such people is a long and complex process and requires a comprehensive approach.

Numerous correlations between functional injuries of the musculoskeletal system and indicators of physical and mental state are noted in the subject literature (Bocheliuk, Turubarova, 2011; Bismak, Melnyk, 2010; Hryhorenko, Hloba, Vytsko, 2008, etc.). Further texts point out the negative influence of these health injuries: the work of individual organs and systems of the human body, primarily the nervous, cardiovascular, respiratory, and digestive systems (Omelchenko, Prystynskyi, 2015).

Many years of experience in Ukrainian and world practice of working with disabled people with musculoskeletal system injuries have shown that physical culture and sports together with psychological correction are an efficient way of ensuring the effectiveness of the rehabilitation process. The psychophysical rehabilitation of disabled people allows for the optimal correlation of therapeutic, psychological, and social factors and thus provides their intellectual, emotional, and psychophysical adaptation to environmental conditions.

However, the analysis of foreign and domestic scientific literature shows that the effective use of physical training means is complicated due to the lack of development of the structure of corrective physical training, correction and compensation of motor actions, the adaptation of disabled people with cervical spinal cord injuries to the social relations, and the development of their didactic and rehabilitation motivation.

The purpose of the study is to highlight the results of the development of a correctional-directed system of optimal recovery of disabled people with musculoskeletal system injuries, the development and compensation of motor actions, psychophysical qualities, mental and neuromuscular performance capability, and the formation of positive motivation in the process of special training. All of this should contribute to the improvement of their living conditions and their integration into the society.

MATERIALS AND METHODS

Participants.

150 students (including 90 boys and 60 girls) aged 16 to 18 with incomplete cervical spinal cord injuries participated in the study. The experiment involved 30 students who were selected based on age, gender, defect structure, and homogeneity of the secondary injuries of the motor sphere.

Organization of the study.

The purpose of the experiment was to study the nature of secondary injuries of the motor sphere depending on the complexity of the defect (physical development, development of basic motor abilities, muscular performance capability, motor-visceral regulation, social and everyday motor skills, and abilities).

The following research methods were used: anthropometry, motor tests, functional tests, electrocardiography, spirometry, assessment of the motor density of correctional classes, questionnaires, and methods of mathematical statistics.

Statistical analysis.

Statistical processing of the obtained data was carried out using the computer program SPSS 19.0. The following criteria were used: Student's t-test and Fisher's angular transformation to identify significant differences in the compared indicators. The sample was checked for the normality of data distribution.

RESULTS

According to the developed method, it was observed that a specific innervation zone is formed in the intact spinal cord up to C7, in which the motor performance capabilities of the neck muscles, shoulder girdle, and upper extremities are completely preserved, while innervated long flexors and small arm muscles are preserved partially. This nature of innervation led to a steady tendency of decreasing indicators of physical development of persons with cervical spinal cord injuries, both boys and girls. Especially distinctive were those declinations which were as high as 62% in the early recovery period (girls - 56.7%), in the late recovery period - 51.3% (girls - 47.4%), and in the residual one - 18% (girls - 12.4%). The indicator of chest rises had the following dynamics in the recovery period among boys: early recovery period - 63.4% (girls - 40%), late recovery period - 61.7%, (girls - 36.7%), residual recovery period - 28.4% (girls - 6.7%), corresponds to this trend. Such a nature of these indicators is predetermined by the fact that when the intact spinal cord is up to C7, respiratory function is inadequate because of paralysis of some respiratory muscles.

The level of motor abilities of persons with cervical spinal cord injuries is also predetermined by the nature of innervation, based on which specific inter-muscle coordination relationships are formed, because of this phenomenon, which is characterized by a decrease in the level of motor abilities. The results among both boys and girls as far as motor abilities, in which the main components are indicators of intramuscular integration and inter-muscular coordination (strength, speed, power, agility) were particularly low. Low level of endurance development in recovery periods (early recovery period for boys - 60%, for girls - 52.7%, late recovery period for boys - 44.4%, for girls - 41.8%, residual recovery period for boys - 12.8%, for girls - 18.3%) was caused by paralysis of some respiratory muscles, whose functions are restored in the

process of rehabilitation, forming morphological and functional prerequisites for the development of special and aerobic endurance.

The dynamics of the indicators of motor abilities of persons with cervical spinal cord injuries as a result of physical rehabilitation are shown in Tables 1-3.

Table 1. Dynamics of indicators of motor abilities of disabled people with cervical spinal cord injuries during the early period of physical rehabilitation

Motor abilities	Early period		
	Control group M ± m	Experimental group M ± m	p
Strength (kilos)			
Right hand	28.9±6.8	39.7±7.3	0.001
Left hand	25.7±9.4	39.3±0.1	0.001
Speed and power abilities (m)	1.5 ±0.3	1.9±0.5	0.001
Simple motor reaction (mps)	296.7±10.1	261.4±9.2	0.001
Frequency of movements (number of times)	5.0±1.3	6.0±2.2	0.001
Agility (points)			
Right	25.3±0.7	31.4±0.6	0.001
Left	23.1±0.6	27.4±0.7	0.001
Endurance	125.0±0.7	226.4±2.9	0.001

Table 2. Dynamics of indicators of motor abilities of disabled people with cervical spinal cord injuries during the late period of physical rehabilitation

Motor abilities	Late period		
	Control group M ± m	Experimental group M ± m	p
Strength (kilos)			
Right hand	39.5± 8.6	49.3±10.1	0.001
Left hand	35.3±9.8	48.6±9.8	0.001
Speed and power abilities (m)	1.9±0.2	4.4±0.3	0.001
Simple motor reaction (mps)	279.4± 9.9	254.6±9.1	0.001
Frequency of movements (number of times)	6.0±1.3	8.3±2.6	0.001
Agility (points)			
Right	29.7±0.6	39.9±0.6	0.001
Left	26.4± 0.8	37.9±1.2	0.001
Endurance	180.1±1.9	266.3±2.1	0.001

Table 3. Dynamics of indicators of motor abilities of disabled people with cervical spinal cord injuries during the residual period of physical rehabilitation

Motor abilities	Residual period		
	Control group M ± m	Experimental group M ± m	p
Strength (kilos)			
Right hand	52.3±11.6	65.3±12.9	0.001
Left hand	50.6±15.4	58.3±12.1	0.001
Speed and power abilities (m)	5.7±0.4	7.6±0.3	0.001
Simple motor reaction (mps)	266.7± 9.6	249.6±8.7	0.001
Frequency of movements (number of times)	8.3±2.7	11.3±4.5	0.001
Agility (points)			
Right	32.9±0.9	44.7±0.8	0.001
Left	29.7±0.9	39.7±0.7	0.001
Endurance	121.4±1.7	110.1±1.6	0.001

In the course of the experiment, it was observed that if persons with cervical spinal cord injuries in the late recovery period had a physical load of force character of 90%, then they were able to perform 2 series of 2 repetitions; 80% load - 3 series of 4 repetitions; 70% - 5 series, 3 series of which were of 5 repetitions and 2 series were of 4 repetitions, and 60% load - 3 series of 6-7 repetitions, 2 series of 5 repetitions and 2 series of 3 repetitions. This indicator increased statistically in the residual recovery period ($p \leq 0.001$). With a power of 80% there were 6 series, 2 of which were of 5 repetitions ($p \leq 0.001$), 3 -of 4 repetitions ($p \leq 0.001$), and 1 series was of 2 repetitions; with a power of 70% there were 8 series ($p \leq 0.001$), 4 series of them were of 6 repetitions ($p \leq 0.001$), 3 -of 4-5 ($p \leq 0.001$) and 1 -of 2 repetitions; with a power of 60% there were 9 series ($p \leq 0.001$), 6 series of them were of 7-9 repetitions ($p \leq 0.001$) and 3 series were of 4-6 repetitions ($p \leq 0.001$).

It was observed that muscular performance capability of speed and power character had a phase structure, the clarity of which was determined by the power of physical activity used for correction. The neurological status of the patient had the greatest influence on the quantitative parameters of muscular performance capability. Thus, in the early recovery period, persons with cervical spinal cord injuries were able to withstand the following physical activity: with a power of 90% - 2 series of 11 repetitions; with a power of 80% - 3 series of 16 repetitions; with a power of 70% - 4 series of 23 repetitions and with a power of 60% - 5 series of 34 repetitions. These dynamics of indicators of muscular performance capability are obtained in the early recovery period.

During the late recovery period, the basic performance capability parameters of speed and power statistically increased. Thus, the maximum result increased to 6.4 ± 0.1 m ($p \leq 0.001$), and performance capability under the conditions of serial repetitions of a given load was characterized by the following: patients were able to lift physical loads of 90% in 2 series of 20.1 ± 0.3 repetitions ($p \leq 0.001$), of 80% - 4 series of 31.7 ± 0.2

repetitions ($p \leq 0.001$), of 70% - 5 series of 40.5 ± 0.2 repetitions ($p \leq 0.001$) and of 60% up to 65.3 ± 0.5 repetitions in 11 series ($p \leq 0.001$).

In the residual period, the indicator of the muscular performance capability of speed and power of persons with cervical spinal cord injuries continued to increase. Thus, the absolute result reached 7.2 ± 0.1 ($p \leq 0.001$), and the maximum number of repetitions (100% of power) reached 27.0 ± 0.3 times ($p \leq 0.001$). Disabled people made physical exercises with a power of 90% in the quantity of 2 series of 33.2 ± 0.5 repetitions ($p \leq 0.001$), with a power of 80% - 4 series of 44.0 ± 0.5 repetitions ($p \leq 0.001$), with a power of 70% and 60% indicators of performance capability were characterized by the stability of their further increase.

Therefore, it was observed that the muscular performance capacity of persons with cervical spinal cord injuries was of a phase nature when performing physical endurance exercises. The duration and quality parameters of this physical load were determined by neurological status, the force of the physical activity, and the period of rehabilitation. Thus, in the late recovery period, patients could perform loads with 90% power at a rate of 50 rpm 2 series with a loading duration of 1.19 ± 0.52 min. And 1.27 ± 0.71 min. with 80% power - 4 series, load range from 2.03 ± 0.81 min. up to 2.04 ± 0.75 min., with a power of 70% - series, loading in the range of 2.47 ± 0.76 min. up to 2.50 ± 0.81 min. and 60% power - 6 series with load from 3.31 ± 1.96 min. with 3.35 ± 3.10 min.

In the residual recovery period, muscular performance capability was characterized by a statistically probable tendency to increase its basic parameters. Thus, physical load with a power of 90% at a tempo of 50 rpm. performed with a load increase of 23.4 ($p \leq 0.001$), with 80% power - 19.7% ($p \leq 0.001$), with 70% power - 26.9 ($p \leq 0.001$).

The experimental complex program of rehabilitation involves the implementation of the following stages: the early stage of corrective work with students with cervical spinal cord injuries; the intermediate rehabilitation phase of corrective work with students with cervical spinal cord injuries; the late stage of corrective work; physical and psychological rehabilitation of students; motivational and preparatory stage of physical rehabilitation in residual period; motivational and training stage of physical rehabilitation of persons with spinal cord injuries in residual period; motivational and progressive stage of physical rehabilitation of students in the residual period.

The stages were regulated by individual psychophysiological characteristics of the patient (the level of spinal cord injuries, the condition of the motor sphere, the quality of motor-visceral regulation, systematic physical exercises in the pre-traumatic period, the level of didactic and rehabilitation, etc.). It was also emphasized, that the stages are only conditional divisions of the rehabilitation process and they reflect psychophysiological and biomechanical patterns of mastering motor actions of the development of physical qualities.

In the process of organizing the study, it was taken into account that the development of young people's physical qualities, training motor actions, and formation of compensatory mechanisms would be more effective if they underwent special types of training that serve a projective function in the stage structure of rehabilitation work.

These included:

- motor training: at each stage, taking into account individual psychophysiological characteristics, a sufficiently high level of basic physical qualities that determine the essence of motor action (strength, speed, speed and power qualities, flexibility, endurance, agility) will be developed;
- psychological training: sufficiently high level of mental stability, adequate health status, motor sphere, and neuromuscular capacity, necessary in the development of physical qualities, formation of new motor actions and compensatory mechanisms, development of positive diagnostic and rehabilitation motivation;
- coordination training: optimal level of coordination capabilities, adequate to the coordination structure of motor actions, including assessment and control actions, visual-motor, and motor-visceral regulation.

The methodology of knowledge formation was constructed taking into account the principle of differential-integral optimals of pedagogical factors in psychophysical rehabilitation, the realization of which ensured their positive orientation of activity in conditions of correctional work. This combination of pedagogical and psychological conditions formed a positive orientation for the intensive search for information concerning the effectiveness of various forms of physical rehabilitation, the results of auto-experiments, and increased the level of consciousness and activity in conditions of organized and independent exercises.

It should be noted that we considered the level of physical education as the most important condition for increasing the efficiency of implementing a phased structure of the psychophysical rehabilitation of the study subjects. At each stage, the activities of psychologists and educators activities were aimed at the optimal formation of a positive „I-concept” of each student’s personality. At the same time, several tasks were completed: the formation of a conscious attitude to the quality of their mental and physical standards and capabilities; systematic orientation of activities in correctional and rehabilitation practice at achieving positive results; the de-actualization of anxiety, psychopathic conditions due to the disease, the development of specific optimal expectations for the future; the formation of a conscious understanding of the positive nature of changes in the sphere of their psychophysical abilities, etc.

As a result of the work, it was determined that the following had a positive effect on persons with disabilities: psychological assistance of consultative nature (individual counseling); different forms of psychotherapy (group, individual); training sessions. Emotional self-regulation techniques, meditative and art-therapeutic techniques were recognized to be effective in group psychotherapy.

The results of the study showed that there were significant positive changes in the experimental group in all indicators, which were reflected in a stable tendency to improve the parameters of motor-visceral regulation and the quality of structural components of a motor system. Thus, the motor sphere of persons with cervical spinal cord injuries in the late recovery period was characterized by an increase in strength indicators up to 42.8% ($p \leq 0.001$), speed – up to 23.8% ($p \leq 0.001$), speed and power abilities - 34.8% ($p \leq 0.001$), endurance - 28.7% ($p \leq 0.001$), agility 14.2% ($p \leq 0.001$). This tendency continued in residual period with the following indicators: strength – up to 10.9% ($p \leq 0.001$), speed – up to 15.3% ($p \leq 0.001$), endurance – up to 12.4% ($p \leq 0.001$), agility – up to 7.9% ($p \leq 0.001$), the accuracy of movements increased up to 38.6% ($p \leq 0.001$), flexibility – up to 14.3% ($p \leq 0.001$) speed and power – up to 18, 3% ($p \leq 0.001$),

the motor response increased up to 47.6% and the response to a moving object up to 39.8% ($p \leq 0.001$).

Implementation of the complex stage-by-stage structure of physical and social rehabilitation of older students with incomplete cervical spinal cord in the residual period provided a stable tendency for further improvement of the qualitative state of the motor sphere: the power of the upper and lower extremities reached 50-52 kilos, speed qualities were 249.6 meters per second, speed and power capabilities reached 7-8.5 m; agility was measured by the indicators of right and left upper extremities so that it was 44.7 and 39.8 points, endurance was equal to 110.1 s.

Comparative analysis of the presented indicators of the motor sphere of control and experimental groups was statistically significant (the indicator t was in the range of 2.75-3.26, $p \leq 0.001$), and didactic-rehabilitation motivation achieved a significant improvement. Thus, 95% of the participants in the experimental group think that exercises and sports are vital for them; 92% are sure that they will exercise and regularly practice sports; 98% will participate in sports competitions; 95% want to participate in sports clubs for persons with disabilities; 85% have a conscious interest in the specialized literature on physical and social rehabilitation. Thus, a hypothetically predicted and experimentally validated approach to the construction of a phased structure of psychophysical rehabilitation of persons in such a category was proven to be effective.

DISCUSSION

Literature analysis, case histories, observations, and special studies show that the most mobile vertebrae C5-C6 of the cervical spine are traumatic injuries (Omelchenko, Prystynskyi, Prystynska 2005; Tsizh, 2006). The pathological condition of the spinal cord in the cervical spine causes spastic paralysis of the lower extremities. Partial and temporary hand muscle paralysis may also occur. In such conditions, the patient's attempts to move, lead to a sharp increase in spastic muscle tension that can cause the development of spastic contractures with minor muscle atrophy and specific negative mental reactions in behavior.

According to studies completed by V. Hryghorenko (2008), these complex phenomena can be overcome and rehabilitated only by the gradual influence of psychological, social, and therapeutic factors in rehabilitation. The psychophysical rehabilitation of traumatic incomplete cervical spinal cord injury is divided into three main periods, which provide the opportunity to take into account the complex structure of the defect, conditions for optimal development, correction of important motor skills and abilities, and the formation of compensatory mechanisms, development of the system of basic motor qualities and abilities. Such a step-by-step structure allows the patients to experience stability and form optimistic expectations about their abilities. This is very important during long-term psychological support and continuous psychophysical and social rehabilitation of the disabled.

The general increase in spinal cord injuries can be attributable to several reasons. These are the following (Zinoviev, Grigorenko, Vitsko, Shtereb, 2007):

1. Traumatic injuries of the spinal cord due to mechanical impact - falling from a height (30% of all injuries), being crushed by heavy loads (25%), transport accidents (14-15%), diving in shallow water (10%), household and sports trauma (10-15%).
2. Infectious diseases of the spinal cord.
3. Congenital and hereditary defects and diseases of the spinal cord.
4. Vascular diseases of the spinal cord.
5. Spinal cord tumors, metabolic disorders.

The effectiveness of complex rehabilitation and the use of physical training for persons with spinal cord injuries is possible only in case of a thorough knowledge of the types of spinal cord injury.

CONCLUSIONS

1. It has been shown that rehabilitation was related to such categories as adaptation, re-adaptation, psychological care, and so on. In the narrow sense, rehabilitation means restoration of health, and in the broad sense, it implies an improvement of psychophysical and functional condition and efficiency that was caused by illnesses, injuries, and other factors.
2. Dynamics of psychophysical development, motor readiness, and motor-visceral regulation of people with cervical spinal cord injuries are determined by the nature of a primary defect, the structure of secondary deviations, and the effectiveness of the process of corrective physical training and rehabilitation in general.
3. The system of socio-psychological factors (physical exercises, methods of training motor actions and development of intellectual, emotional, and volitional and also physical qualities, kinds of classes, equipment, etc.) that are used in training in general and in psychophysical rehabilitation, is regulated by the basic parameters of physical activity. These are power, volume, time of one-time influence, intervals of recovery and orientation of physical activity, adequacy of a complex of training methods (the combination of strictly regulated methods of studying with verbal methods and methods of visual demonstration and formation of positive didactic and rehabilitation motivation).
4. The results of the study showed low indicators of psychophysical development and motor readiness of people with cervical spinal cord injuries. Structural analysis of the motor sphere has shown that psychophysical rehabilitation should be organized as a step-by-step structure with operational, motivational, and regulatory components of activity.
5. The results of the experiment have shown high indicators regardless of the criteria applied. Implementation of a comprehensive step-by-step program of psychophysical rehabilitation of older students with incomplete cervical spinal cord injuries in the residual period provided a stable tendency for further improvement of the indicators of the qualitative state of motor sphere, mental state, and social adaptation.
6. Comparative analysis of the indicators of the motor sphere in control and experimental groups was statistically certain. The indicators of didactic and rehabilitation motivation have significantly improved. It was observed that the positive factors that positively influenced the physical and mental state of the disabled were the following: reduction in the level and intensity of negative experiences about health; focus on productive activity, goal achievement, success, personal fulfillment, etc.

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CECHY REHABILITACJI OSÓB Z USZKODZENIAMI RDZENIA KRĘGOWEGO

STRESZCZENIE

W artykule przedstawiono wyniki badań dotyczących specyfiki rehabilitacji młodzieży po urazach rdzenia kręgowego w odcinku szyjnym. Celem pracy jest przygotowanie optymalnego programu rehabilitacji, związanego z rozwojem motorycznym i kompensacją ruchową, cechami fizycznymi, stanem psychicznym, funkcjonowaniem nerwów i mięśni, a także kształtowanie pozytywnej motywacji podczas specjalnych programów treningowych, co pomoże przystosować się do nowej sytuacji, przyciągnąć i zintegrować ze społeczeństwem.

Wyniki eksperymentu ustalającego wykazały dość niski poziom rozwoju motoryki, regulacji trzewnego układu motorycznego, motoryki manualnej i umiejętności życia codziennego. Istotą pracy eksperymentalnej jest rehabilitacja korekcyjna w trzech fazach (wczesna, późna, rezydualna).

W badaniu wzięło udział 150 uczniów, w tym 90 chłopców i 60 dziewcząt w wieku od 16 do 18 lat, z niepełnymi uszkodzeniami rdzenia kręgowego w odcinku szyjnym. Eksperymentalnie udowodniono, że głównymi warunkami psychologicznymi i pedagogicznymi, które w pełni zapewniają skuteczność rehabilitacji psychofizycznej i społecznej uczniów w podanym wieku, z niepełnym uszkodzeniem rdzenia kręgowego w odcinku szyjnym są: tworzenie komfortowych warunków i sytuacji, które kształtują optymistyczne oczekiwania co do swoich możliwości oraz pozytywną motywację do rehabilitacji dydaktycznej; kompleksowe podejście do korekcji z wykorzystaniem czynników psychologicznych i społecznych, specyficzny trening motoryczny, metody kontroli i kształtowania zdolności motorycznych, rozwój fizyczny, korekcja i kompensacja ruchowa; kontrola poziomu podstawowych umiejętności motorycznych; kompleksowe podejście do adaptacji społecznej; wysoki poziom aktywności fizycznej każdej osoby niepełnosprawnej w oficjalnych i niezależnych formach fizjoterapii.

Specjalnie zorganizowane szkolenie, według wszystkich kryteriów i wskaźników, pozytywnie wpłynęło na uczniów z grupy eksperymentalnej, w przeciwieństwie do grupy kontrolnej, w której wskaźniki pozostały na dość niskim poziomie.

SŁOWA KLUCZOWE

korekcja, rehabilitacja, uraz rdzenia kręgowego, rozwój fizyczny.



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