

Physical Rehabilitation Program for Students of the Special Medical Group

Nataliya GOLOD¹,
Zoryana KORYTKO²,
Ljudmyla RUSYN³,
Mykola BALUKH⁴,
Volodimir YAKOVLIV⁵,
Ihor HNYP⁶

¹ Ivano-Frankivsk National Medical University, Ivano-Frankivsk, Ukraine, n.golod@ukr.net

² Ivan Boberskyi Lviv State University of Physical Culture, Ukraine, korytko@ukr.net

³ Uzhhorod national university, Uzhhorod, Ukraine, ljударusyn@gmail.com

⁴ Khmelnytskyi Humanitarian-Pedagogical Academy, Khmelnytskyi, Ukraine, balukh.mykola@gmail.com

⁵ Vinnitsia Mykhailo Kotsiubynskiy State Pedagogical University, Vinnitsia Ukraine, dekykovliv576@gmail.com

⁶ Lviv State University of Internal Affairs, Lviv, Ukraine, igi_2008@ukr.net

Abstract: *Most of the current programs of physical rehabilitation of students of a special medical group (hereinafter - SMG) are aimed only at a separate contingent depending on the type of nosology, which complicates the work of the teacher and reduces the effectiveness of classes for other students. In fact, no physical rehabilitation programs have been developed for female students who have the highest reproductive potential. Therefore, the creation of a rehabilitation program that will not only be able to cover students with various diseases, but will also be useful for the prevention of risk factors for chronic noncommunicable diseases (CHD) as the most acute demographic problem is relevant. The purpose of the study is to develop, scientifically substantiate and test the program of physical rehabilitation of students of a special medical group, taking into account motor disorders. The developed program of physical rehabilitation of SMG students taking into account motor impairments had a complex character and included the following elements: lifestyle modification, kinesitherapy (with stoppage of fitness yoga, functional training, aerobic training) (swimming, fitness, jogging, health) self-massage with the Lyapko applicator. The control group included 24 individuals, the experimental group consisted of two groups of 24 individuals. The following methods were used to solve the research tasks: analysis of scientific and special literature, surveys and questionnaires, pedagogical testing, methods of determining indicators of physical development, physical fitness and functional state of the organism, methods of mathematical statistics. After the implementation of the developed program of physical rehabilitation for female students, a decrease in the number and intensity of modified risk factors for CHD due to increased physical activity, reduction of bad habits was determined; reducing the number of complaints. Studies on the effectiveness of the program of physical rehabilitation of female students, taking into account motor impairments, tested on a sufficient number of female students of the special medical group, have confirmed data and can serve as a basis for practical implementation of this program.*

Keywords: *motor impairment, lifestyle modification, kinesitherapy, aerobic training, functional training, self-massage with Lyapko applicator.*

How to cite: Golod, N., Korytko, Z., Rusyn, L., Balukh, M., Yakovliv, V., & Hnyp, I. (2022). Physical Rehabilitation Program for Students of the Special Medical Group. *BRAIN. Broad Research in Artificial Intelligence and Neuroscience*, 13(1), 484-509. <https://doi.org/10.18662/brain/13.1/295>

Introduction

In 2011, the UN declared an epidemic of non-communicable diseases in the world. By 2030, the WHO forecasts an increase in deaths from them to 52 million per year. Chronic non-communicable diseases (CHD) include diseases of the circulatory system, malignant neoplasms, chronic obstructive pulmonary disease, diabetes and more. CHDs cause global socio-economic losses to many countries around the world, including Ukraine. They determine the level of total mortality of the entire population of our country by 82.8% and by 62.4% - mortality in working age (Gorbas, 2009). Currently, the risk factors that lead to CHD have been studied. It is proved that eight risk factors cause up to 75% of deaths from these types of pathology: hypertension, dyslipidemia, smoking, malnutrition (insufficient consumption of fruits and vegetables, excessive consumption of salt, animal fats and excessive caloric intake), low physical activity, high levels blood glucose, overweight and obesity, and frequent alcohol consumption.

Ukraine, like most European countries, is characterized by a significant prevalence of risk factors for CHDs, which leads to a deepening of the epidemic, significant medical and social losses and economic losses. In the WHO European Region ranking, Ukraine ranks fourth in terms of standardized mortality rates of the working age population due to cancer, fifth in terms of the corresponding mortality rate from diseases of the circulatory system and alcohol consumption per capita, and ninth in terms of smoking prevalence among men (Gorbas, 2009). At the same time, according to such indicators of a healthy lifestyle as the level of physical activity, consumption of vegetables and fruits per person per day, Ukraine ranks 32nd among European countries (Davydenko, 2006; Dudnyk, 2013). Thus, the high prevalence of risk factors in the population indicates an unfavorable epidemiological situation for CHD in the population of Ukraine, which requires more active use of methods of prevention and correction of the consequences of these diseases in all age groups, especially young people at risk.

Youth health is an urgent problem and a matter of paramount importance, as it determines the future of the country, the nation's gene pool, scientific and economic potential of society (Bodnar, 2014; Andriyчук, 2015). Preservation and strengthening of students' health, formation of their health values is possible with the choice of educational technologies, adequate to the categories and needs of students. According to a study by the Ukrainian Research Institute of Child and Adolescent Health, no more than 10-15% of children aged 7-18 can be considered healthy.

Accordingly, the number of students enrolled in special medical groups (SMG) is increasing every year and has doubled in the last 10 years. Thus 12-18% of students are directed for employment in special medical groups for the purpose of application of complexes of medical physical training (Repnevskaya, 2009).

The problem of physical education and correction of health of students of SMG is paid a lot of attention by Ukrainian scientists (Platonov, 2006; Dubogai, Tsos, & Evtushok, 2012; Koryagin, & Blavt, 2013; Maksymchuk, 2020a; Maksymchuk, 2020b, Palamarchuk, 2020, Sheremet, 2019; Bakhmat, 2019; Behas, 2019; Bezliudnyi, 2019; Halaidiuk, 2018; Maksymchuk, 2018; Sitovskyi, 2019). However, they all note that the existing programs and assessment criteria at the state level are obsolete and do not meet the physical capabilities of modern youth, and the full recovery of such students remains an urgent problem of physical rehabilitation. For students studying at SMG, the discipline "Physical Education" is often the only opportunity to receive physical rehabilitation, because the exercises for them are based on the principles of kinesitherapy. However, in this situation the teacher has some difficulties, because in the framework of regulated classes he must simultaneously work with students with various chronic diseases. This requires finding new methodological approaches to correcting the health of SMG students.

Neurophysiological aspects of physical rehabilitation of female students

In the late 20th century, it became possible to experimentally prove positive effects from taking into account the mechanisms of brain activity on the effectiveness of rehabilitation programmes, especially for people with brain injuries. It was then believed that a detailed neurophysiological diagnosis and appropriate medical history should precede the actual physical or psychological rehabilitation. In the 1980s, however, scientists predicted a rapid expansion in the use of neurosciences in various types of rehabilitation, which occurred during "the quantum leap" in brain research in the 1990s-2000s (Caplan, 1982, p. 362).

The neurophysiological aspect in physical rehabilitation can be used not only as diagnostic or propaedeutic. As part of experiment, D'Agatha et al. (2016) exercised regular influence on patients with chronic stroke due to repeated transcranial magnetic stimulation (rTMS) and transcranial direct-current stimulation (tDCS) to restore motor activity during the rehabilitation of the upper extremities. They also studied the clinical effect patients with mild and moderate cognitive and motor disorders. A relevant result for this

research is the fact of the dependence of cognitive and motor changes after the above-mentioned rehabilitation: the rate of limb muscle contraction and agility increased after 6 months of neurorehabilitation.

Neurophysiological measurement of limb strength (comparison of right and left ones) during rehabilitation on fitness equipment (mostly, bicycles and on treadmills), seems to be valid for the research. Neurophysiologists are now equipped with devices to assess bilateral reflexes by modulating skin reflexes that are electrically stimulated (irritation of the superficial radial nerve in the wrist). Such reflexes can be assessed directly during movement and at rest, and then processed in test mode. It allows one to assess the rehabilitation progress of gait, balance, coordination and other cerebrovascular indicators (Diac et al., 2020). Such long-term physical rehabilitation controlled by neurophysiological indicators gives clear results. According to Kaupp et al. (2018), the results show significant changes in function and neurophysiological integrity. Exercise increases the force of bilateral grip and strength during plantar flexion and muscle activation. The normalization of skin reflex modulation was detected during cyclic movement (Kaupp et al., 2018). Thus, it is promising for Ukrainian rehabilitation centres to be equipped with devices for diagnosing the condition and dynamics of central pattern generator networks.

Today, physical rehabilitation increasingly uses automated simulators and robots, which programmatically take into account the neurophysiological data of the identified disorders and even displace the rehabilitation specialists themselves. According to Major et al. (2020), there is currently competition between classical and robotic physiotherapy. Prospects are seen in the expedient interchangeability of human and technological factors in physical rehabilitation. Moreover, the latter factor can comprehensively and multimodally take into account the neurophysiological assessment of the musculoskeletal system (encephalogram, motor conductivity, degree of motor amplitude) (Major et al., 2020; Amunts et al., 2007; Apanasenko, 2007; Ardila, Rosselli, Matute, & Inozemtseva, 2011).

Discussing the expediency of using automated and robotic technologies for physical rehabilitation, researchers claim that the correction of sensorimotor deficits by such methods should be based on neurophysiological and interdisciplinary indicators and control. Importantly, the restoration of sensorimotor function after CNS injury is based on the use of neuroplasticity with an emphasis on the rehabilitation of movements necessary for independence. It requires physiological activation of the muscles of the extremities, which can be achieved through functional

exercises for the movement of the arms / hands and feet and the activation of the corresponding peripheral receptors (Gassert, & Dietz, 2018). Therefore, physical rehabilitation without anthropogenic intervention should be followed by the constant use of sensors that would monitor the neurophysiological and physical condition of patients undergoing such rehabilitation.

One should also pay special attention to neurophysiological and psychophysiological studies which consider the specifics of gender (physical, motivational, emotional and activity prerogatives of women and men) so that they can be further implemented in physical rehabilitation programmes. Kozina, Sobko, Klimenko, & Sak (2013) devoted their study to certain neurophysiological indicators and subjective changes in the well-being of female basketball players. They draw an important conclusion as a result of heart rate measurements during training and identification of the subjective state of health. Indeed, it is more difficult for female students aged between 20 and 22 to withstand physical activity than for first-year students and teenage girls. This can be explained by neurophysiological specifics (completed formation of the female body and, respectively, a higher coefficient of heat stroke and the degree of subjective severity) (Kozina, Sobko, Klimenko, & Sak, 2013). Such gender-oriented and age-specific features provide important empirical material for developing rehabilitation and physical education programmes for girls of all ages and will be taken into account by the author in further research.

It is important to take into account physical and neurophysiological differences of gender for studies on women. Sensory-motor, cognitive and physical features of men and women have long been studied and described in science. However, comprehensive studies on neurophysiological specificity of women are rather interesting, given that such specificity can be recorded using Digit Span, Digit Symbol and Block Design tests in combination with other types of diagnostics. Polunin, Bryun, Sydniaeva, & Golukhova (2018) studied the mental state, speech, motility and other neurophysiologically relevant indicators and proved a consistent gender pattern in several differences. Indeed, psychomotor speed and verbal fluency predominate in women and visual-spatial orientation in men (Polunina, Bryun, Sydniaeva, & Golukhova, 2018). These data can form the basis of recommendations for physical and psychological rehabilitation and collective influence for people of different sexes.

Thus, one can conclude that those types of physical rehabilitation associated with traditional hobbies of modern girls (fitness, step aerobics, callanetics) are more acceptable for female students, given gender priorities.

Callanetics requires particular attention since it is a static set of exercises, which is primarily relevant for post-traumatic rehabilitation. The studies conducted among first-year students (a 72-hour programme with a change in daily routine and nutrition) has revealed not only an improvement in anthropometric, neurophysiological and subjective valeological indicators but also positive changes in motivation for static and dynamic exercises (Kolomiytseva, & Anatskyi, 2017). This observation may be an impetus for the inclusion of callanetics in the rehabilitation process, in particular for girls and women.

It is known that girls are less prone to active motor actions (physical education, rehabilitation or sports) due to their psychophysiology. Normally, and especially as pathology, this phenomenon is called “kinesiophobia”, that is individual psychological or trauma-induced fear of physical movements. Kinesiophobia as a result of negative motor experience (trauma, exhaustion) can be a serious obstacle to physical rehabilitation of young people. Indian researchers have shown through an experimental study that 16-year-old girls with a negative traumatic experience should undergo propaedeutic and / or psychological rehabilitation before physical rehabilitation. This will protect them from the behaviour of avoiding physical rehabilitation (Wane, Naqvi, Vaidya, & Kumar, 2020). Such generalizations correlate with the observed fact of caution, bias or avoidance of physical post-traumatic stress in Ukrainian students.

Unfortunately, the analysis of domestic (Ukrainian) scientific sources suggests that most of the current programs of physical rehabilitation of SMG students are aimed only at a certain contingent depending on the type of nosology, which complicates the work of the teacher and reduces the effectiveness of classes for other students. In fact, no physical rehabilitation programs have been developed for female students who have the highest reproductive potential. Therefore, the creation of a rehabilitation program that will not only be able to cover students with various diseases, but will also be useful for the prevention of risk factors for CHD as the most acute demographic problem is relevant. The consideration of neurophysiological and neuropsychological factors still remains a promising area of Ukrainian rehabilitation.

The purpose of the study is to develop, scientifically substantiate and test the program of physical rehabilitation of students of a special medical group, taking into account motor impairments.

Materials and methods

To solve the problems a set of research methods is used, adequate to the purpose of the research: analysis of scientific and special literature; surveys and questionnaires (questionnaires to clarify complaints from the body's major systems, assess their health, awareness and control of anthropometric and functional indicators of the body, the presence of risk factors for chronic non-communicable diseases; specification of physical activity during school; International Physical Activity Questionnaire (IPAQ) (abbreviated); anthropometric examination (height, body weight, body mass index, waist circumference, hip circumference, ratio of waist and hip circumference, chest girth and excursion; basic and wrist dynamometry, index of lifting force and hand strength); determination of the state of the cardiovascular (heart rate, blood pressure) and respiratory systems (respiratory rate, pulse oximetry device "UTASOXI 200" (Ukraine), computer spirometry device "SpiroCom Standard" 3.1.0122.10040 : National Aerospace University " Kharkiv Aviation Institute", Kharkiv), the state of the autonomic nervous system (test with isometric load, orthostatic test). The state of motor capacity was determined by indicators of physical fitness: strength (flexion and extension of the arms in a lying position, squats on two legs), speed (time of the basketball at 10 m, running on the spot, raising the knees to an angle of 90 ° for 5 s), endurance (transition from the position of squatting to the position of lying down, six-minute walk), agility (hitting the ball on target in 10 attempts and in the basketball hoop), flexibility (distance from fingertips to the floor when tilted to the side, body tilt forward) and (Functional Movement Screen (FMS)).

The obtained results were processed by methods of mathematical statistics using the computer program Microsoft Excel.

The developed program of physical rehabilitation of SMG students taking into account motor impairments s had a complex character and included the following elements: lifestyle modification, kinesitherapy (with stoppage of fitness yoga, functional training, aerobic training) (swimming, fitness, jogging, health) self-massage with the Lyapko applicator (tab. 1).

When developing the rehabilitation program, the methodological principles of conducting classes with SMG students were taken into account according to the "Typical curriculum for students of higher medical educational institutions of III-IV levels of accreditation". Also, this program and work plans of the discipline "Physical Education", adopted by the Department of Physical Education and Health of the State Higher Educational Institution "Ivano-Frankivsk National Medical University"

determined the number of classroom and independent classes and the sequence of mastering physical skills used in the rehabilitation program, i.e. the created program was adapted to physical education classes as part of the SMG visit.

In the process of developing the program of physical rehabilitation of SMG students, the requirements of adequacy, regulation and strict dosage of physical activity were observed; their regularity; gradual expansion of means to ensure a comprehensive impact on the internal organs and musculoskeletal system; selection of fitness yoga exercises, functional training, aerobics in accordance with the type of limitations of motor capacity of female students; tried to improve the psycho-emotional state of female students.

The complexity of the impact of the developed program included the impact not only on the physical component of health due to the positive impact of exercise on the cardiovascular, respiratory, autonomic nervous system, the parameters of physical development and physical fitness. The social and psychological components also underwent positive changes - due to the feeling of improving health; increasing the level of household activity; creating the image of a modern person, free of bad habits, a future doctor who, by the example of his own health.

Table 1. *The structure of the rehabilitation program for students of the special medical group, taking into account motor impairments*

Stage	Month (calendar)	Training mode	Tasks	Methods	
Preparatory	0	gentle	<i>initial control</i>	morning hygienic gymnastics (MHG) daily (independent classes)	
			adaptation of all body systems to increasing physical activity, mastering the proposed techniques, correction of motor disorders, development of physical qualities, general endurance, correction of psycho-emotional state, motivation to lead a healthy lifestyle	fitness yoga 2 times in two weeks (classes) 1 time in 2 weeks (independent employment)	
	1		training-gentle	<i>intermediate control</i>	functional training Once a week classroom 2 times in two weeks (independent classes)
					wellness course logging daily (independent classes)
Basic	1	training-gentle	improving the function of the cardiovascular, respiratory, autonomic nervous systems,	MHG daily (independent classes)	
	2			functional training Once a week classroom 2 times in two weeks (independent classes)	
				swimming 2 times a week (classes)	

kinesitherapy program
 lifestyle modification (self-massage with applicators Ivanko)
 nutrition correction multi-needle

			correction of motor impairments, further development of physical qualities, improvement of back posture, training	health walking	daily (independent classes)		
		training	<i>intermediate control</i>	MHG	daily (independent classes)		
			consolidation of the obtained results, further improvement and stabilization of the function of internal organs, further expansion of physical activity, maintaining the achieved level of physical fitness, increase overall endurance, further improvement of physical qualities	health aerobics	3 times in two weeks (classes)		
				functional training	3 times in two weeks (independent classes)		
			<i>final control</i>	wellness course jogging	daily (independent classes)		

Results

In the examined students SMG1 and SMG2, subjective signs of the following syndromes were identified: cardiac, hyperventilation, dyspeptic, cephalic, neuroendocrine, polyarthralgic, astheno-neurotic. Almost a quarter of the students of the special medical group assessed their state of health as rather bad and bad, which is 4 times higher than the similar indicator of their healthy age-mates (24% vs. 6%). The survey also showed a low level of awareness and control of the main anthropometric and functional indicators of the body in both groups of respondents. It is established that the lifestyle of SMG1 and SMG2 students is characterized by the presence of modified risk factors for CHD: bad habits, insufficient physical activity, signs of malnutrition, chronic stress, as well as the impact of burdened heredity. When determining the level of household and physical activity according to the developed questionnaire, it was found that students SMG1 and SMG2 have a pronounced tendency to hypokinesia and static lifestyle, low interest in health training.

Although the level of physical activity according to the International Physical Activity Questionnaire (IPAQ) of SMG1 and SMG2 and KG students did not differ statistically, during the calculation of energy consumption it was determined that SMG1 and SMG2 students (respectively 1232.92 ± 190.84 MET and 1272.82 ± 123.80 ME (Metabolic equivalent)

statistically significantly lag behind the girls CG in the level of total weekly energy expenditure (1826.38 ± 183.14 ME) ($p < 0.05$).

When conducting anthropometric measurements, it was found that the students of SMG1 and SMG2 were smaller than the representatives of the control group were the average values of chest girth on inhalation and exhalation, chest excursion ($p < 0.05$). Other studied indicators (height, body weight, waist and hip circumference) probably did not differ.

The study of body muscle strength showed a significant decrease in body muscle strength and, accordingly, the index of postural strength in female students SMG1 and SMG2 compared with CG (control group) on the background of unchanged hand strength.

Examination of the functional state of the respiratory system showed worse parameters of the Stange test (32.08 ± 2.10 s), acceleration of respiratory rate at rest in students SMG1 and SMG2 (respectively 21.67 ± 0.83 and 19.17 ± 0.80 per minute .), decrease in FEV1 (forced expiratory volume) (respectively $86.65 \pm 3.46\%$ and $83.56 \pm 3.39\%$) and FEV (respectively $84.26 \pm 3.26\%$ and $82.90 \pm 3.45\%$) compared with control analogues ($p < 0.05$) against the background of unchanged Hensler index ($p > 0.05$), which is characteristic of restrictive type disorders. The consequence of the violation of external respiration was a statistically significant decrease in the degree of oxygenation of arterial blood of female students SMG1 and SMG2 ($93.3 \pm 0.18\%$ and $94.3 \pm 0.27\%$, respectively).

The condition of the cardiovascular system of SMG students was also disturbed. The mean resting heart rate in girls SMG1 and SMG2 was significantly higher (90.9 ± 2.45 beats / min and 90.1 ± 1.79 beats / min, respectively) from the control analogue (2.93 beats / min.), Which can be explained as a compensatory response of the cardiovascular system in response to dysfunction of external respiration and a decrease in the degree of oxygenation of arterial blood. Blood pressure readings were unchanged.

When conducting tests to establish the functional state of the autonomic nervous system (orthostatic test, with isometric load) in students SMG1 and SMG2 found increased tone of the nerve centers of the sympathetic nervous system.

Motor ability ("movement abilities", "sprawność ruchowa") was defined as the ability to control one's musculoskeletal system through the development of motor skills (Gilewicz, 1994). The increase in motor capacity depends on the acquired skills and sports achievements, respectively, the decrease - characterizes the disease or low state of physical development. The study used two approaches to determine motor disorders:

determining the level of general physical fitness and testing on the screen of functional movement.

After testing the students involved in the study to assess their physical fitness, it was found that students SMG1 and SMG2 were inferior to CG students in terms of strength (squats on two legs, flexion and extension of the arms in a supine position), endurance (dynamics 6- you minute test, transition from the position of the stop squatting to the position of the stop lying down), speed (according to the parameters of the time of the basketball on 10 m, running on the spot, raising the knees to an angle of 90 ° for 5 s), agility (number of hits in a goal of 10 attempts or in a basketball hoop), flexibility (in terms of inclination to the side and forward), which resonated with the low results of tests.

To assess motor impairments, we also used a modern information test - Functional Movement Screen (FMS). The FMS includes seven basic motor models that require balance, mobility and stability: 1) deep squats; 2) step over the barrier; 3) linear attack; 4) shoulder mobility; 5) active lifting of the straight leg; 6) stability of the torso when stretching the arms; 7) circular stability. Each exercise was evaluated on a 3-point system. Impaired motor capacity of students SMG1 and SMG2 was confirmed by complications and low grades when performing all FMS exercises.

At the initial examination according to the results of all tests, the indicators of female students SMG1 and SMG2 did not differ statistically significantly ($p > 0.05$). Identified at this stage of the study, the above pathological changes in the body of students of special medical groups argued the need and served as a basis for the development of a comprehensive program of physical rehabilitation based on the improvement of motor capacity and its testing.

After a long implementation of the program we developed for the physical rehabilitation of students of a special medical group, taking into account motor impairment, its expressive beneficial effect on the majority of the analyzed indicators of physical development and the functional state of the body was determined.

The results of the repeated survey of female students showed a decrease in the intensity of all complaints of SMG2 female students, normalization of the menstrual cycle, reduction of the share of meteorologically dependent persons among them. There was also an increase in self-esteem, a decrease in the number of bad habits (smoking, alcohol consumption), as well as an increase in the level of physical activity of this group of girls. The dynamics of subjective perception of SMG1 students has not changed significantly.

Analyzing the results of the survey of female students on the International Physical Activity Questionnaire (IPAQ) after the implementation of the rehabilitation program, we can conclude that the time that respondents spent on different types of physical activity increased only in SMG2 students. They also significantly exceeded the parameters of SMG1 in terms of energy expenditure on foot, performing intense physical activity and total weekly load ($p < 0.05$) (Table 2).

Table 2. Dynamics of weekly energy consumption of SMG students after the implementation of the rehabilitation program ($M \pm m$)

Energy consumption	CG (n=24)		SMG1 (n=24)		SMG2 (n=24)	
	initial examination	final examination	initial examination	final examination	before FR	after FR
Footing, ME	554,41 $\pm 23,00$	508,75 \pm 54,31	404,25 \pm 96,12	429,00 ± 5 9,42	425,15 \pm 63,25	585,75 \pm 49,48 **,***
To perform loads of moderate intensity, ME	360,00 $\pm 29,41$	342,83 \pm 42,13	248,67 \pm 69,47	254,67 ± 6 8,10	277,00 \pm 65,15	310,00 \pm 39,92
To perform high-intensity loads, MET	911,97 $\pm 64,04$	870,00 \pm 83,60	580,00 \pm 164,25	593,33 ± 8 5,60 *	570,67 \pm 72,98 *	800,00 \pm 51,64 **,***
Total weekly load, ME	1826,38 \pm 183,14	1721,58 $\pm 115,52$	1232,92 $\pm 190,84$ *	1277,00 \pm 123,40 *	1272,82 $\pm 123,80$ *	1695,75 $\pm 112,70$ **,***

Notes: * - statistically significant difference in comparison with the value of the corresponding CG ($p < 0,05$);

** - statistically significant difference compared to its value before the implementation of the program ($p < 0,05$);

*** - statistically significant difference compared to the value of the corresponding indicator SMG1 ($p < 0,05$).

When determining anthropometric indicators, it was revealed that during the final examination, SMG1 students did not show a pronounced change in weight, height, body mass index, chest circumference on exhalation and inspiration, waist and hips, the ratio of waist to hip circumference relative to the initial result. At the same time, statistically significant growth dynamics of the chest excursion rate (up to 6.6 ± 0.21 cm) were determined for SMG2 students, which indicates an improvement

in the respiratory function of the lungs and an increase in respiratory reserves in the representatives of this group.

During the post-dynamic dynamometry, a slight increase in back muscle strength was found in female SMG1 (up to 48.67 ± 3.29 kg) and a marked increase in SMG2 girls (up to 91.67 ± 2.21 kg) relative to initial index. (0.05). Accordingly, the index of class strength has changed. When measuring the strength of the wrist, it was found that it increased in SMG1 students, but increased statistically insignificantly ($p > 0.05$). At the same time, SMG 2 students showed a marked increase in the strength of the right and left hands ($p < 0.05$). The hand strength index also increased statistically significantly only in girls SMG2 ($p < 0.05$).

The results of the re-examination showed a significant improvement in the functional parameters of the respiratory organs, blood circulation and the state of the autonomic nervous system of SMG2 students under the influence of the rehabilitation program compared to the initial examination.

Thus, the improvement of the functional reserves of the respiratory system was manifested in an increase in the duration of respiratory arrest on inspiration and exhalation (according to the results of the Stange (43.08 ± 2.83 s) and Gench tests (28.08 ± 1.13 s)) statistically significant in girls SMG2 ($p < 0.05$). They also determined the normalization of respiratory rate at rest.

At repeated inspection improvement of ventilatory function by results of spirometry (increase in size of forced lung capacity (FLC) ($95,00 \pm 3,15\%$), FEV1 ($97,17 \pm 3,14\%$)) is more expressed at SMG2 students in comparison with SMG1 ($p < 0, 05$). The value of the modified index indicated the absence of obstructive changes in students of both groups. Confirmation of the improvement of the functional state of the respiratory organs were the results of the dynamics of the degree of oxygenation of arterial blood of SMG2 students ($99.83 \pm 0.11\%$).

With positive results ahead of time, the dynamics of indicators of the heart-ship system are normalized: normalization of systolic blood pressure (SBP), diastolic blood pressure (DBP) heart rate in the presence of a representative of SMG2.

Normalization of the balance of the autonomic nervous system due to the reduction of sympathicotonia based on the samples with isometric load, orthostatic test.

The pathological deviations of the initial functional parameters, which adversely affected the ability to tolerate physical activity, as evidenced by the test at the initial examination, decreased at the second. The Ruffier index for SMG1 students was rated "satisfactory", while for SMG2 girls it

reached "good". The structure of the evaluation of the results of the test has changed: in SMG2, compared to the initial survey, there were students with grades of "good" and "excellent", which was not found in SMG1.

Against the background of improving physical development, a decrease in signs of motor impairment was revealed. The indicators of physical fitness of SMG2 students have improved: strength and speed abilities, endurance, agility and flexibility. The introduction of a physical rehabilitation program for students of special medical groups caused a pronounced positive impact on the physical condition of girls, which was reflected in the results of all FMC exercises (Table 3) and the structure of their assessment more pronounced in SMG2 girls compared to SMG1 students ($p < 0.05$).

Table 3. Change of the screen of functional movement after implementation of the rehabilitation program, points ($M \pm m$)

Test, points	CG (n=24)		SMG1 (n=24)		SMG2 (n=24)	
	initial exami nation	final exami nation	initial exami nation	final exami nation	before FR	after FR
№ 1. «Deep squat»	2,71± 0,09	2,58± 0,14	1,58± 0,30*	2,08± 0,22	1,08± 0,32*	2,75± 0,13**,***
№ 2. «Step over the hurdle»	2,88± 0,07	2,96± 0,04	2,42± 0,14*	2,50± 0,14*	2,33± 0,18*	2,92± 0,08**,***
№ 3. «Linear lunge»	2,92± 0,06	2,83± 0,08	2,25± 0,13*	2,42± 0,14*	2,25± 0,17*	2,92± 0,08**,***
№ 4. «Shoulder mobility»	3,00± 0,01	2,96± 0,04	2,83± 0,11	2,67± 0,18	2,75± 0,17	3,00± 0,01
№ 5. «Active lifting of the straight leg»	2,83± 0,08	2,67± 0,10	2,00± 0,20*	2,17± 0,16*	2,17± 0,23*	2,83± 0,11**,***
№ 6. «Stability of the body when stretching the arms»	2,71± 0,11	2,63± 0,10	1,50± 0,19*	1,92± 0,14*	1,83± 0,23*	2,83± 0,16**,***

№ 7 «Circular stability»	3,00±	3,00±	3,00±	2,8	2,8	2,8	2,8	2,5	2,8	2,5	2,8	2,5	2,8	2,5
	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01

Notes: * - statistically significant difference in comparison with the value of the corresponding CG (p <0,05);

** - statistically significant difference compared to its value before the implementation of the program (p <0,05);

*** - statistically significant difference compared to the value of the corresponding indicator SMG1 (p <0,05)

Discussion

The article presents a theoretical generalization and a new solution to the problem associated with the correction of motor disorders of SMG students and, as a consequence, improving the functioning of physiological systems of the body.

For the first time, the expediency of eliminating risk factors for chronic non-communicable diseases, the development of physical qualities and improving the physical fitness and functional state of the body of female students to eliminate motor impairments; the degree of motor impairment of students of basic and special medical groups was determined with the use of the Functional Movement Screen testing program; the expediency of including in the program of physical rehabilitation of students modification of their lifestyle, fitness yoga, functional and aerobic trainings (health-improving gait, jogging, swimming, health-improving aerobics), massage is substantiated; proved the effectiveness of the developed set of rehabilitation measures to reduce the number of risk factors for chronic diseases, reduce the degree of motor impairment, improve physical development, functional and physical fitness of SMG students. *Improved* information on physical development, functional status and physical fitness of students of special medical and basic groups. *Acquired further development* of knowledge about the methods of physical rehabilitation of SMG students, including by finding a new approach to assessing their physical condition.

The practical significance of the study is determined by the creation of a rehabilitation program for students of special medical group, the use of which allows to reduce the level of physical development, as well as physical and functional fitness of students to reduce risk factors for chronic non-communicable diseases, improve the functioning of physiological systems. The program can be the basis for effective correctional work among SMG students. At the same time, it can be used in the practice of physical

rehabilitation specialists, physical education teachers, trainers of secondary schools, rehabilitation institutions and health centers.

Such that **confirm** the results of previous studies are: the state of health of students of special medical groups remains an urgent problem of modern medicine (Apanasenko, 2007) and physical rehabilitation (Platonov, 2006; Dubogai, Tsos, & Evtushok, 2013; Koryagin, & Blavt, 2013); the problem of finding a unified approach to physical education classes for students of special medical groups remains extremely relevant in medical, pedagogical and rehabilitation practice and requires further understanding, study, scientific and experimental justification (Chaban, 2002; Vrzhesnevskyy, 2006; Malakhova, 2011; Blavt, 2013).

The need to use modern technologies of physical education and physical rehabilitation, adapted to the interests and needs of modern youth (Ivanochko, 2011; Buleychenko, Sheremet, & Yanchenko, 2013; Vilyanskyy, Chernihiv, & Prykhodko, 2013; Grokhova, 2013; Bodnar, 2014; Andriychuk, 2015; Goloviychuk, 2015); it is advisable to use physical rehabilitation to correct health impairments of students of special medical groups (Moseychuk, 2007; Repnevskaya, 2009).

Complementing the results of previous studies are: the importance of the problem of low interest of students in leading a healthy lifestyle and the spread of risk factors among them (Galizdra, 2004; Levandovskyy, 2006; Omelchenko, 2011; Bodnar, 2014); data on the causes and progression of health impairments of students of special medical groups (Levandovskyy, 2006; Makarova, & Bashkin, 2012); about disturbances of physical development, functional and physical readiness of students of special medical groups (Ivanochko, 2011; Goloviychuk, 2013; Dotsenko, 2013); about the favorable effect of physical rehabilitation measures on physical development, functional, physical fitness of students of special medical groups (Olkhovyyk, 2011; Onyshchuk, 2011; Bochkova, 2013).

The following data are **completely new**: for the first time in the contingent of SMG students it was found that low risk of physical activity, eating disorders, bad habits are the risk factors for the emergence of CHD; for the first time the degree of motor impairments of students of basic and special medical groups was determined with the use of the Functional Movement Screen testing program; for the first time the differences in the complexes of indicators of motor capacity, functional and physical fitness of students of the special medical group in comparison with similar indicators of students of the main medical group were clarified; the expediency of elimination of risk factors for chronic non-communicable diseases, development of physical qualities and improvement of physical fitness and

functional condition of internal organs of SMG students for elimination of motor impairments is substantiated; the expediency of including in the program of physical rehabilitation of students modification of their lifestyle, fitness yoga, functional training, aerobic training (health walking, jogging, swimming, health aerobics), massage is substantiated.

Conclusions

The state of health of young people, in particular students, is an urgent problem and an important task of national importance, as it determines the gene pool of the nation, the future of the country, the economic and scientific potential of Ukraine. However, in recent years there has been deterioration in the general health of the population, which is reflected in an increase in the number of students who study in special medical groups.

Most of the existing programs of physical rehabilitation of SMG students are aimed only at certain groups of students depending on the type of disease, which reduces the effectiveness of classes for other students and complicates the work of the teacher. Therefore, it is important to create a rehabilitation program that will not only be able to cover students with various nosological forms, but also has a preventive effect on risk factors for CHD as an acute demographic problem.

The lifestyle of female students of the special medical group is characterized by the presence of modified risk factors for CHD: bad habits, low physical activity, malnutrition. Female students showed subjective signs of cardiac, hyperventilation, dyspeptic, cephalic, neuroendocrine, polyarthralgic, astheno-neurotic syndromes. The level of weekly energy consumption of SMG students was 1272.82 ± 123.80 MET, and healthy students - 1826.38 ± 183.14 MET ($p < 0.05$). Also lower were the average values of chest girth on inhalation and exhalation, chest excursion ($p < 0.05$). Examination of the functional state of the respiratory system showed a decrease in the parameters of the Stange test, FEV1 ($83.56 \pm 3.39\%$) and forced vital capacity of the lungs ($82.90 \pm 3.45\%$) of SMG students compared with control analogues ($p < 0.05$). The consequence of the violation of external respiration was a decrease in the degree of oxygenation of arterial blood of SMG students ($94.3 \pm 0.27\%$). When conducting tests to establish the functional state of the autonomic nervous system (orthostatic, with isometric load) in SMG students found a violation of the balance of its parts in the direction of sympathicotonia. Impaired motor capacity of students of the special medical group was manifested in reduced ($p < 0.05$ relative to students of the main medical group) parameters of strength,

flexibility, endurance, agility, speed, which echoed the low results of the test. It is also confirmed by complications and low scores when performing all FMC exercises.

The developed rehabilitation program for students of the special medical group included lifestyle modification, kinesitherapy (with the use of fitness yoga, functional training, aerobic training (swimming, fitness, jogging, health aerobics), massage, was aimed at differentiated correction reducing the impact of modified risk factors for CHD, improving the functioning of the cardiovascular, respiratory and autonomic nervous systems. The program is adapted for use in physical education classes in special medical groups of universities. The complex nature of the applied means and methods of physical rehabilitation is associated with the simultaneous impact on various functional systems of the body and on the three components of the human essence - physical, mental and social.

After the implementation of the developed program of physical rehabilitation for female students, a decrease in the number and intensity of modified risk factors for CHD due to increased physical activity, reduction of bad habits was determined; reducing the number of complaints. The level of weekly energy consumption increased (1695.75 ± 112.70 MET, $p < 0.05$). It was found that statistically significant dynamics of growth of the chest excursion index (6.6 ± 0.21 cm) was determined in SMG students. Dynamometry showed an increase in the strength of the muscles of the back, right and left hands ($p < 0.05$). The improvement of the ventilatory function of the respiratory system was manifested in a significant increase in the duration of respiratory arrest on inhalation and exhalation (according to the results of the tests); increases in the parameters of forced vital capacity of the lungs ($95.00 \pm 3.15\%$) and FEV1 (97.17 ± 3.14) ($p < 0.05$); improving the degree of oxygenation of arterial blood ($99.83 \pm 0.11\%$) ($p < 0.05$). The balance of the autonomic nervous system was normalized due to the reduction of sympathicotonia according to the results of the calculation of the test with isometric load, orthostatic test ($p < 0,05$).

As a result of the developed rehabilitation program, the ability to tolerate physical activity has improved, as evidenced by the test. The index reached "good" ($p < 0.05$). The structure of evaluation of test results has changed: in comparison with the initial examination, students with evaluation "good" and "excellent" were found. Reduction of motor impairments was revealed: significant relative to the initial examination ($p < 0.05$) improvement of students' physical fitness: strength, endurance, speed, agility, flexibility. Such dynamics was reflected in the results of all FMC exercises and in the structure of their evaluation. The positive

dynamics of the state of health of students who were engaged in a typical program of physical education in special medical groups was not noted.

Studies on the effectiveness of the program of physical rehabilitation of female students, taking into account motor impairments, tested on a sufficient number of female students of the special medical group, have confirmed data and can serve as a basis for practical implementation of this program.

We see prospects for further research in the development of a program of physical rehabilitation of young students studying in a special medical group, taking into account motor impairments.

References

- Amunts, K., Armstrong, E., Malikovic, A., Hömke, L., Mohlberg, H., Schleicher, A., Zilles, K. (2007). Gender-specific left-right asymmetries in human visual cortex. *Journal of Neuroscience*, 2(6), 1356–1364.
<https://www.jneurosci.org/content/27/6/1356>
- Andriychuk, O. Ya. (2015). Kilkisnyy sklad spetsialnykh medychnykh hrup zalezno vid roku navchannya ta spetsialnosti (sered studentiv-medykiv) [Quantitative composition of special medical groups depending on the year of study and specialty (among medical students)]. *Fizychnye vyklovannya, sport i kultura zdorovya u suchasnomu suspilstvi* [Physical Education, Sport and Health Culture in Modern Society], 1(29), 67–74.
http://nbuv.gov.ua/UJRN/Fvs_2015_1_17
- Apanasenko, H. L. (2007). *Knyha o zdorove* [A book on health]. Medknyha.
http://www.irbis-nbuv.gov.ua/cgi-bin/irbis_nbuv/cgiirbis_64.exe?Z21ID=&I21DBN=EC&P21DBN=EC&S21STN=1&S21REF=10&S21FMT=fullwebr&C21COM=S&S21CNR=20&S21P01=0&S21P02=0&S21P03=A=&S21COLORTERMS=1&S21STR=%D0%90%D0%BF%D0%B0%D0%BD%D0%B0%D1%81%D0%B5%D0%BD%D0%BA%D0%BE%20%D0%93
- Ardila, A., Rosselli, M., Matute, E., & Inozemtseva, O. (2011). Gender differences in cognitive development. *Developmental Psychology*, 47, 984–990.
doi:10.1037/A0023819
- Bakhmat, N., Maksymchuk, B., Voloshyna, O., Kuzmenko, V., Matviichuk, T., Kovalchuk, A., Maksymchuk, I. (2019). Designing cloud-oriented university environment in teacher training of future physical education teachers. *Journal of Physical Education and Sport*, 19 (4), 1323-1332.
<http://efsupit.ro/images/stories/august2019/Art%20192.pdf>
- Behas, L., Maksymchuk, B., Babii, I., Tsymbal-Slatvinska, S., Golub, N., Golub, V., Maksymchuk, I. (2019). The influence of tempo rhythmic organization of

- speech during gaming and theatrical activities on correction of stammering in children. *Journal of Physical Education and Sport*, 19 (4), 1333-1340.
<http://efsupit.ro/images/stories/august2019/Art%20193.pdf>
- Bezliudnyi, O., Kravchenko, O., Maksymchuk, B., Mishchenko, M., Maksymchuk, I. (2019). Psycho-correction of burnout syndrome in sports educators. *Journal of Physical Education and Sport*, 19(3), 1585-1590.
<http://efsupit.ro/images/stories/septembrie2019/Art%20230.pdf>
- Blavt, O. Z. (2013). Suchasnyy stan systemy testuvannya u fizychnomu vykhovanni spetsial'nykh medychnykh hrup VNZ [The current state of the testing system in the physical education of special medical groups of universities]. *Scientific Journal of M. P. Dragomanov National University. Series 15: Scientific and Pedagogical Problems of Physical Culture (Physical Culture and Sports)*, 4(29), 107–113.
- Bochkova, N. L. (2013). Parametry fizkulturno-ozdorovchykh zanyat yak faktor korektsiyi funktsionalnoho stanu studentiv z arterialnoyu hipertenziyeyu [Parameters of physical culture and health classes as a factor in the correction of the functional state of students with hypertension]. *Scientific Journal of M. P. Dragomanov National University. Series 15: Scientific and Pedagogical Problems of Physical Culture (Physical Culture and Sports)*, 4(29), 139–143. <https://intellect.kpi.ua/profile/bnl/publications>
- Bodnar, I. (2014). Porivnyalna kharakterystyka skarh na zdorovya u shkolyariv riznykh medychnykh hrup [Comparative characteristics of health complaints in schoolchildren of different medical groups]. *Young Sports Science of Ukraine*, 18(3), 16–22.
<http://repository.ldufk.edu.ua/handle/34606048/157>
- Buleychenko, O. V., Sheremet, O. L., & Yanchenko, I. M. (2013). Vplyv sportyvnoho oriyentuvannya na psykhoemotsiynnyy stan studentiv spetsialnykh medychnykh hrup [Influence of sports orientation on the psycho-emotional state of students of special medical groups]. *Scientific Journal of M. P. Dragomanov National University. Series 15: Scientific and Pedagogical Problems of Physical Culture (Physical Culture and Sports)*, 4(29), 147–151.
- Caplan, B. (1982). Neuropsychology in rehabilitation: Its role in evaluation and intervention. *Archives of Physical Medicine & Rehabilitation*, 63, 362–366.
<https://europepmc.org/article/med/7052012>
- Chaban, I. P. (2002). Kompleksnyy pidkhid v rozrobsi novykh tekhnolohiy prohramuvannya zanyat fizychnoho vykhovannya iz studentamy spetsialnoho medychnoho viddilennya [Complex approach in the development of new technologies for programming physical education classes with students of the special medical department]. *Pedagogy, Psychology and Medical Biological Problems of Physical Education and Sports*, 16, 3–10.

- [http://www.irbis-nbuv.gov.ua/cgi-bin/irbis_nbuv/cgiirbis_64.exe?Z21ID=&I21DBN=REF&P21DBN=REF&S21STN=1&S21REF=10&S21FMT=fullwebr&C21COM=S&S21CNR=20&S21P01=0&S21P02=0&S21P03=A=&S21COLORTERMS=1&S21STR=%D0%A7%D0%B0%D0%B1%D0%B0%D0%BD%20%D0%86\\$](http://www.irbis-nbuv.gov.ua/cgi-bin/irbis_nbuv/cgiirbis_64.exe?Z21ID=&I21DBN=REF&P21DBN=REF&S21STN=1&S21REF=10&S21FMT=fullwebr&C21COM=S&S21CNR=20&S21P01=0&S21P02=0&S21P03=A=&S21COLORTERMS=1&S21STR=%D0%A7%D0%B0%D0%B1%D0%B0%D0%BD%20%D0%86$)
- D'Agata, F., Peila, E., Cicerale, A., Caglio, M. M., Caroppo, P., Vighetti S., Piedimonte, A., Minuto, A., Campagnoli, M., Salatino, Molo, M. T., Mortara, P., Pinessi, L., & Massazza, G. (2016). Cognitive and neurophysiological effects of non-invasive brain stimulation in stroke patients after motor rehabilitation. *Frontiers in Behavioral Neuroscience*, 10, 1–11. <https://doi.org/10.3389/fnbeh.2016.00135>
- Davydenko, N. V. (2006). Dynamika osoblyvostey kharchuvannya ta sertsevosudynni zakhvoryuvannya (15-richne doslidzhennya) [Dynamics of nutrition and cardiovascular disease (15-year study)]. *Problemy kharchuvannya* [Problems of Nutrition], 6. http://www.medved.kiev.ua/arh_nutr/art_2006/n06_3_3.htm.
- Diac, M., Oprea, R., Iov, T., Damian, S-I., Knieling, A., & Bulgaru Iliescu, A. (2020). Finite Elements Models of the Head in Craniocerebral Trauma – Review. *BRAIN. Broad Research in Artificial Intelligence and Neuroscience*, 11(1Sup1), 08-21. <http://dx.doi.org/10.18662/brain/11.1Sup1/25>
- Dotsenko, O. M. (2013). Vzayemozvyazok parametriv fizychnoho rozvytku, fizychnoyi pidhotovlenosti i koordynatsiy nykh zdibnostey u studentok spetsial'noyi medychnoyi i osnovnoyi hrup [The relationship between the parameters of physical development, physical fitness and coordination skills in students of special medical and basic groups]. *Scientific Journal of M. P. Dragomanov National University. Series 15: Scientific and Pedagogical Problems of Physical Culture (Physical Culture and Sports)*, 4(29), 325–330. <http://eadnurt.diit.edu.ua/jspui/handle/123456789/1821>
- Dubogai, O. D., Tsos, A. V., & Evtushok, M. V. (2012). *Metodyka fizychnoho vykhovannya studentiv spetsialnoyi medychnoyi hrupy: navchalnyy posibnyk dlya studentiv vyshchobo navchalnobo zakladu* [Methodology of physical education of students of a special medical group: a textbook for students of a higher educational institution]. Lutsk: Eastern European National University named after Lesya. <http://esnuir.eenu.edu.ua/bitstream/123456789/1619/1/posibnyk.pdf>
- Dudnyk, S. (2014). Chomu i yak khvoriyut ukrayintsi? [Why and how do Ukrainians get sick?]. *Vashe zdorovya* [Your Health], 42-43. <http://www.vz.kiev.ua/chomu-i-yak-xvoriyut-ukraïnci/>
- Galizdra, A. A. (2004). Kharakterystyka faktoriv, shcho vplyvayut na zdorovya studentiv vyshchyykh navchal'nykh zakladiv [Characteristics of factors

- influencing the health of students of higher educational institutions]. *Teoriya ta metodyka fizychnoho vykhovannya*. [Theory and Methods of Physical Education], 3, 41–43. <https://tmfv.com.ua/journal/article/view/138>
- Gassert, R., & Dietz, V. (2018). Rehabilitation robots for the treatment of sensorimotor deficits: a neurophysiological perspective. *Journal of NeuroEngineering and Rehabilitation*, 15(46), 1–15. <https://doi.org/10.1186/s12984-018-0383-x>
- Gilewicz, Z. (1994). *Teoria wychowania fizycznego* [The theory of physical education]. Warszawa: PWN. <https://archiwum.allegro.pl/oferta/teoria-wychowania-fizycznego-zygmunt-gilewicz-i8417931362.html>
- Goloviychuk, I. (2015). Vprovadzhennya zasobiv yohy v navchalnyy protses fizychnoho vykhovannya studentiv spetsialnoyi medychnoyi hrupy [Implementation of yoga in the educational process of physical education of students of a special medical group]. *Scientific Journal of M. P. Dragomanov National University. Series 15: Scientific and Pedagogical Problems of Physical Culture (Physical Culture and Sports)*, 3(1), 110–112. http://nbuv.gov.ua/UJRN/Nchnpu_015_2015_3%281%29_34
- Gorbas, I. M. (2009). Profilaktyka khronichnykh neinfektsiynykh zakhvoryuvan – realnyy shlyakh polipshennya demohrafichnoyi sytuatsiyi v Ukraini [Prevention of chronic non-communicable diseases - a real way to improve the demographic situation in Ukraine]. *Ukrayinskyy kardiologichnyy zhurnal* [Ukrainian Journal of Cardiology], 3, 6–11. http://tests.ifnmu.edu.ua:8080/library/DocDescription?doc_id=15645
- Grokhova, H. P. (2013). Rekreatyvni zasoby dlya pidvyshchennya funktsional'noho stanu zdorov'ya studentiv spetsial'noyi medychnoyi hrupy [Recreational means for improving the functional health of students of a special medical group]. *Scientific Journal of M. P. Dragomanov National University. Series 15: Scientific and Pedagogical Problems of Physical Culture (Physical Culture and Sports)*, 4(29), 302–307.
- Halaidiuk, M., Maksymchuk, B., Khurtenko, O., Zuma, I., Korytko, Z., Andrieieva, R., Maksymchuk, I. (2018). Teaching approaches in extracurricular physical activities for 12-14-year-old pupils under environmentally unfavourable conditions. *Journal of Physical Education and Sport*, 18 (4), 2284–2291. <http://efsupit.ro/images/stories/decembrie2018/Art%20344.pdf>
- Ivanochko, V. V. (2011). *Vplyv ozdorovyvnykh fitness-probam na fizychnyy stan studentok iz zakhvoryuvannyam kardiorespiratornoyi systemy* [Influence of health-improving fitness programs on the physical condition of students with cardiorespiratory system diseases]. *Moloda sportivna nauka Ukrainy*, 15(2), 92–97. <http://repository.ldufk.edu.ua/handle/34606048/1192>
- Kaupp, C., Pearcey, G. E., Klarner, T., Sun, Y., Cullen, H., Barss, T. S., & Zehr, E. P. (2018). Rhythmic arm cycling training improves walking and

- neurological integrity in chronic stroke – the arms can give legs a helping hand in rehabilitation. *Journal of Neurophysiology*, 119, 1095–1112.
<https://doi.org/10.1152/jn.00570.2017>
- Kolomyitseva, O., & Anatskyi, R. (2017). Fitness callanetics in physical education of girl students. *Physical Education of Students*, 21(2), 66–71.
<https://doi.org/10.15561/20755279.2017.0203>
- Koryagin, V., & Blavt, O. (2013). *Fizychnye vykhovannya studentiv u spetsialnykh medychnykh brupakh* [Physical education of students in special medical groups]. Lviv Polytechnic Publishing House.
- Kozina, Zh. L., Sobko, I. N., Klimenko, A. I., & Sak, N. N. (2013). Comparative characteristics of psychophysiological features skilled basketball players-women with hearing and skilled basketball players healthy. *Pedagogics, Psychology, Medical-Biological Problems of Physical Training and Sports*, 7, 28–33.
<https://doi.org/10.6084/m9.fgshare.735962>
- Levandovskyi, O. S. (2006). Metodyka aktyvizatsiyi rukhovoyi aktyvnosti studentiv z oznakamy vehetatyvnoho dysbalansu [Methods of activation of motor activity of students with signs of vegetative imbalance]. *Pedahohika, psykholohiya ta medyko-biologichni problemy fizychnogo vykhovannya i sportu* [Pedagogy, Psychology and Medical Biological Problems of Physical Education and Sports], 4, 90–94.
- Major, Z. Z., Vaida, C., Major, K. A., Tuca, P., Simori, G., Banica, A., Brusturean, E., Burz A., Craciunas, R., Ulinici, I., Carbone, G., Gherman, B., Birlescu, I., & Pisla, D. (2020). The impact of robotic rehabilitation on the motor system in neurological diseases. a multimodal neurophysiological approach. *International Journal of Environmental Research and Public Health*, 17, 6557.
<https://doi.org/10.3390/ijerph17186557>
- Makarova, E., & Bashkin, I. (2012). Efektyvnist prohram fizychnoyi reabilitatsiyi v patsiyentiv iz posturalnymy y lokomotornymy porushennyamy [The effectiveness of physical rehabilitation programs in patients with postural and motor impairments]. *Molodizhnyy naukovyy visnyk Volynskoho natsional'noho universytetu im. Lesi Ukrayinky. Seriya: Fizychnye vykhovannya i sport* [Youth Scientific Bulletin of Volyn National University named after Lesya Ukrainka. Series: Physical Education and Sports], 7, 83–87.
<http://esnuir.eenu.edu.ua/handle/123456789/3473>
- Maksymchuk, B., Gurevych, R., Matviichuk, T., Surovov, O., Stepanchenko, N., Opushko, N., Sitovskyi, A., Kosynskyi, E., Bogdanyuk, A., Vakoliuk, A., Solovyov, V., & Maksymchuk, I. (2020a). Training Future Teachers to Organize School Sport. *Revista Romaneasca Pentru Educatie Multidimensionala*, 12(4), 310-327. <https://doi.org/10.18662/rrem/12.4/347>
- Maksymchuk, B., Matviichuk, T., Solovyov, V., Davydenko, H., Soichuk, R., Khurtenko, O., Groshovenko, O., Stepanchenko, N., Andriychuk, Y.,

- Grygorenko, T., Duka, T., Pidlypniak, I., Gurevych, R., Kuzmenko, V., & Maksymchuk, I. (2020b). Developing Healthcare Competency in Future Teachers. *Revista Romaneasca Pentru Educatie Multidimensionala*, 12(3), 24-43. <https://doi.org/10.18662/rrem/12.3/307>
- Maksymchuk, I., Maksymchuk, B., Frytsiuk, V., Matviichuk, T., Demchenko, I., Babii, I., Savchuk, I. (2018). Developing pedagogical mastery of future physical education teachers in higher education institutions. *Journal of Physical Education and Sport*, 18(2), 810–815. <http://efsupit.ro/images/stories/iunie2018/Art%20119.pdf>
- Malakhova, Zh. V. (2011). Optimizatsiya protsessa fizicheskogo vospitaniya studentov spetsialnoy meditsinskoy gruppy [Optimization of the process of physical education of students of a special medical group]. *Nauka i osvita* [Science and Education], 1, 98–102.
- Moseychuk, Yu. Yu. (2007). Korektsiya psykholohichnykh porushen u studentiv pid vplyvom tryvaloho zastosuvannya systemy kompleksnoyi reabilitatsiyi [Correction of psychological disorders in students under the influence of long-term application of the system of complex rehabilitation. *Visnyk Chernihivskoho derzhavnogo pedahohichnogo universytetu. Seriya: Pedahohichni nauky. Fizychni vykhovannya ta sport* [Collected Papers of Chernihiv State Pedagogical University. Series: Pedagogical sciences. Physical Education and Sports], 44, 468–472.
- Olkhovyyk, A. V. (2011). Fizychna reabilitatsiya studentiv spetsial'noyi medychnoyi hrupy iz zakhvoryuvannyam na veheto-sudynnu dystoniyu za zmishanyim typom [Physical rehabilitation of students of a special medical group with a disease of vegetative-vascular dystonia of mixed type]. *Pedahohika, psykholohiya ta medyko-biologichni problemy fizychnogo vykhovannya i sportu* [Pedagogy, Psychology and Medical Biological Problems of Physical Education and Sports], 10, 54–56. <https://www.sportpedagogy.org.ua/html/journal/2011-10/11oavsmtd.pdf>
- Omelchenko, T. A. (2011). Efektyvnist protsesu zaluchennya studentiv do ozdorovchoyi diyal'nosti [The effectiveness of the process of attracting students to health]. *Proceedings of the International Scientific Conference on Health-Preserving Technologies, Physical Rehabilitation and Recreation in Higher Education*, Kharkiv, Kharkiv State Academy of Design and Arts.
- Onyshchuk, V. Ye. (2011) Fizychna reabilitatsiya studentiv, khvorykh na bronkhialnu astmu shlyakhom kompleksnoho zastosuvannya metodyky “endohenko-hipoksychnoho” dykhannya ta tsyklichnykh vprav aerobnoho spryamuvannya [Physical rehabilitation of students with asthma by complex application of the method of “endogenous-hypoxic” breathing and cyclic exercises of aerobic direction]. *Moloda sportyvna nauka Ukrainy*

- [Young Sports Science of Ukraine], 15(3), 171–177.
<http://repository.ldufk.edu.ua/handle/34606048/1500>
- Palamarchuk, O., Gurevych, R., Maksymchuk, B., Gerasymova, I., Fushtey, O., Logutina, N., Kalashnik, N., Kylivnyk, A., Haba, I., Matviichuk, T., Solovyov, V., & Maksymchuk, I. (2020). Studying Innovation as the Factor in Professional Self-Development of Specialists in Physical Education and Sport. *Revista Romaneasca Pentru Educatie Multidimensionala*, 12(4), 118-136.
<https://doi.org/10.18662/rrem/12.4/337>
- Platonov, V. (2006). *Berezhly zdorovya zmolodu* [Take care of the health of youth. Dzerkalo tyzhnya [Week's Mirror], 47, 2.
https://www.researchgate.net/publication/322759278_Berezi_zdorov'a_z_molodu
- Polunina, A. G., Bryun, E. A., Sydnieva, E. N., & Golukhova, E. Z. (2018). Gender differences in cognitive functions: retrospective analysis of the data of 5 neuropsychological studies. *Scholars Report*, 3(1), 61–75.
https://www.researchgate.net/publication/326225884_Gender_difference_s_in_cognitive_functions_retrospective_analysis_of_the_data_of_5_neuro_psychological_studies
- Repnevskaya, M. S. (2009). Optymizatsiya protsesu fizychnoyi reabilitatsiyi studentiv vyshchoho navchal'noho zakladu [Optimization of the process of physical rehabilitation of students of higher educational institution]. *Pedagogika, psykholohiya ta medyko-biologichni problemy fizychnogo vykhovannya i sportu* [Pedagogy, Psychology and Medical Biological Problems of Physical Education and Sports], 5, 226–229.
<https://www.sportpedagogy.org.ua/html/journal/2009-05/09rmshe.pdf>
- Sheremet M., Leniv Z., Loboda V., Maksymchuk B. (2019) The development level of smart information criterion for specialists' readiness for inclusion implementation in education. *Information Technologies and Learning Tools*, 72, 273-285. <https://journal.iitta.gov.ua/index.php/itlt/article/view/2561>
- Sitovskiy A., Maksymchuk B., Kuzmenko V., Nosko Y., Korytko Z., Bahinska O. Maksymchuk, I. (2019). Differentiated approach to physical education of adolescents with different speed of biological development (2019). *Journal of Physical Education and Sport*, 19(3), 1532 – 1543.
<http://efsupit.ro/images/stories/august2019/Art%20192.pdf>
- Vilyanskyy, N. V., Chernihiv, S. A., & Prykhodko, V. V. (2013). Vplyv tekhnolohiyi neprofesiyanoi fizkulturnoyi osvity na funktsionalnyy stan studentiv, zvilnenykh vid praktychnykh zanyat z “fizychnoho vykhovannya” [Influence of technology of non-professional physical education on the functional state of students exempted from practical classes in “physical education”]. *Scientific Journal of M. P. Dragomanov National University. Series 15:*

Scientific and Pedagogical Problems of Physical Culture (Physical Culture and Sports), 4(29), 190–195. https://kfv.nmu.org.ua/ua/Str_VNV/s_vnv.php

Vrzhesnevskyy, Y. Y. (2006). Unyfytsyrovannaya systema otsenky fizycheskykh vozmozhnostey studentov spetsyal'noho otdelenyia vuza [Unified system for assessing the physical capabilities of students of the special department of the university]. *Pedagogika, psykholohiya ta medyko-biologichni problemy fizychnogo vykhovannya i sportu* [Pedagogy, Psychology and Medical Biological Problems of Physical Education and Sports], 9, 44-48. https://scholar.google.com/scholar?hl=ru&as_sdt=0,5&cluster=33070371568069090

Wane, M., Naqvi, W. M., Vaidya, L., & Kumar, K. (2020). Kinesiophobia in a patient with postoperative midshaft fracture: a case report of its impact on rehabilitation in a 16-year-old girl. *Cureus*, 12(11), Article e11333. <https://doi.org/10.7759/cureus.11333>