

## PHYSICAL REHABILITATION OF ADOLESCENTS WITH MINOR STRUCTURAL CARDIAC ABNORMALITIES

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### Abstract

**Topicality.** The article shows the method of physical rehabilitation of adolescents with minor structural cardiac abnormalities. Minor structural cardiac abnormalities is a large group of cardiovascular anomalies, characterized by the presence of a variety of anatomical and morphological deviations from the norm of the heart structures that make up the undifferentiated connective tissue dysplasia. The most common cardiac manifestations of connective tissue dysplasia syndrome are mitral valve prolapse and abnormal chords of the left ventricle of the heart. Diagnosis of this pathology in adolescents has significantly increased with the development of ultrasound examination of the heart, while the technique of physical rehabilitation has not been sufficiently developed to date. **The aim of the research is** to study the effect of rationally dose-related physical exertion on the severity of the main symptoms of the disease and the physical condition of adolescents with minor structural cardiac abnormalities. **Methods of Work.** Questionnaire to identify a subjective assessment of the severity of the main symptoms of the disease, the definition of exercise tolerance and the index of the physical state of adolescents according to the methodology of Professor O. Shchepin. **Results of Work.** Physical rehabilitation was carried out in three stages, general strengthening exercises of aerobic and anaerobic power, exercises on simulators, sports-applied exercises, outdoor games, respiratory gymnastics, special exercises to increase the stability of the vestibular apparatus, orthostatic firmness, the formation of correct posture and flatfoot prevention. The loads were dosed individually, taking into account the results of determining the tolerance to physical activity. **Conclusion.** As a result of the rehabilitation actions the general conditions of the adolescents were improved, the symptoms of the disease began to disturb them less often and disappear. The index of physical condition increased for boys from an average of  $0,52 \pm 0,007$  to an above average of  $0,70 \pm 0,001$ , and for girls from the lower limit of the average  $0,51 \pm 0,006$  to the upper one and was  $0,69 \pm 0,004$ .

**Key words:** physical rehabilitation, minor structural cardiac abnormalities, index of physical condition.

**Сергій Возний, Юрій Ромаскевич, Петро Годлевський. Фізична реабілітація підлітків із малими структурними аномаліями серця. Актуальність.** У статті наведено методику фізичної реабілітації підлітків із малими структурними аномаліями серця. Малі структурні аномалії серця – це велика група аномалій розвитку серцево-судинної системи, яка характеризується наявністю різноманітних анатомічних і морфологічних відхилень від норми структур серця, що входять до складу недиференційованої дисплазії сполучної тканини. Найбільш поширені кардіальні прояви синдрому дисплазії сполучної тканини – пролапс мітрального клапана й аномальні хорди лівого шлуночка серця. Діагностика цієї патології в підлітків значно зросла з розвитком ультразвукового дослідження серця, у той час як методика фізичної реабілітації до сьогодні розроблена недостатньо. **Завдання роботи** – вивчення впливу раціонально дозованих фізичних навантажень на перебіг основних симптомів захворювання та фізичний стан підлітків із малими структурними аномаліями серця. **Методи проведення роботи** – анкетування виявлення суб'єктивної оцінки основних симптомів захворювання, визначення толерантності до фізичних навантажень та індексу фізичного стану за методикою професора О. П. Щепіна. **Результати роботи.** Фізична реабілітація проводилась у три етапи, використовувалися загальнозміцнювальні вправи аеробно-анаеробної потужності, вправи на тренажерах, спортивно-прикладні вправи, рухливі ігри, дихальна гімнастика, спеціальні вправи на підвищення стійкості вестибулярного апарату, ортостатичної стійкості, формування правильної постави й профілактику плоскостопості. Дозувалися навантаження індивідуально з урахуванням результатів визначення толерантності до фізичного навантаження. **Висновки.** У результаті проведених реабілітаційних заходів у підлітків покращився загальний стан, симптоми хвороби стали їх турбувати рідше, протікати легше й швидше зникати. Індекс фізичного стану підвищився в хлопців із середнього ( $0,52 \pm 0,007$ ) до вищого за середній ( $0,70 \pm 0,001$ ), а в дівчат – із нижньої межі середнього ( $0,51 \pm 0,006$ ) до верхньої ( $0,69 \pm 0,004$ ).

**Ключові слова:** фізична реабілітація, малі структурні аномалії серця, індекс фізичного стану.

**Сергей Возный, Юрий Ромаскевич, Петр Годлевский. Физическая реабилитация подростков с малыми структурными аномалиями сердца. Актуальность.** В статье приводится методика физической реабилитации подростков с малыми структурными аномалиями сердца. Малые структурные аномалии сердца –

это большая группа аномалий развития сердечно-сосудистой системы, характеризующаяся наличием разнообразных анатомических и морфологических отклонений от нормы структур сердца, входящих в состав недифференцированной дисплазии соединительной ткани. Наиболее распространенные кардиальные проявления синдрома дисплазии соединительной ткани – пролапс митрального клапана и аномальные хорды левого желудочка сердца. Диагностика данной патологии у подростков значительно возросла с развитием ультразвукового исследования сердца, в то время как методика физической реабилитации до настоящего времени разработана недостаточно. **Цель исследования** – изучение влияния рационально дозированных физических нагрузок на выраженность основных симптомов заболевания и физическое состояние подростков с малыми структурными аномалиями сердца. **Методы работы** – анкетирование на выявление субъективной оценки выраженности основных симптомов заболевания, определение толерантности к физической нагрузке и индекса физического состояния подростков по методике профессора О. П. Щепина. **Результаты работы.** Физическая реабилитация проводилась в три этапа, использовались общеукрепляющие упражнения аэробно-анаэробной мощности, упражнения на тренажерах, спортивно-прикладные упражнения, подвижные игры, дыхательная гимнастика, специальные упражнения на повышение устойчивости вестибулярного аппарата, ортостатической стойкости, формирование правильной осанки и профилактику плоскостопия. Дозировались нагрузки индивидуально с учетом результатов определения толерантности к физической нагрузке. **Выводы.** В результате проведенных реабилитационных мероприятий у подростков улучшилось общее состояние, симптомы болезни стали их беспокоить реже, легче протекать и быстрее исчезать. Индекс физического состояния повысился у мальчиков со среднего  $0,52 \pm 0,007$  до выше среднего  $0,70 \pm 0,001$ , а у девочек – с нижней границы среднего  $0,51 \pm 0,006$  до верхней и составил  $0,69 \pm 0,004$ .

**Ключевые слова:** физическая реабилитация, малые структурные аномалии сердца, индекс физического состояния.

**Introduction.** Minor structural cardiac abnormalities (MSCA) – is a large heterogeneous group of anomalies in the development of the cardiovascular system, characterized by the presence of various anatomical and morphological abnormalities of the heart structures and is a part of the undifferentiated connective tissue dysplasia. The most common cardiac manifestations of the connective tissue dysplasia syndrome are the mitral valve prolapse (MVP) and abnormal left ventricular chord (ALVC), which as isolated pathology make up to 93–95 % of all MSCA [4; 8]. Diagnosis of this pathology has increased significantly with the development of ultrasonic examination of the heart.

Mitral valve prolapse is the flexing of valve cusp to the left atrium cavity during the ventricular contraction of the heart.

Abnormal left ventricular chord is additional formation in the ventricular cavity having the form of a thin stranded string. This inherited anomaly is 92 % transmitted from maternal lineage, irrespective of patients age, abnormal chord is more often detected in men (17–71 %) than in women (17–30 %). The pathology is more common in young people and adolescents than in middle-aged people [1]. The emergence of MSCA can be ascribed to genetic pathology of connective tissue (Marfan syndrome, Ehlers–Danlos syndrome, etc.) and be inherited [4; 5; 8].

As a rule the structure of the entire connective tissue is changed in children. Therefore, they have a number of features and signs of connective tissue dysplasia: myopia, flatulence, increased mobility of small joints, postures, very elastic skin, dislocation of hip joints, hernia. Usually the children are of asthenic physique, thin and graceful, with weak muscles, often of high stature. Pathology is often accompanied by panic attacks and other psycho-emotional disorders. The majority of children complain of chest pain, palpitations, tachycardia, feelings of heart failure, short breath, dizziness, general weakness, headache, rapid fatigability. Usually such complaints arise due to emotional stress and accompanied by various vegetative reactions (unstable mood, anxiety and fear, extremity coldness, palpitations, sweating, decrease or increase in pressure, headache, etc.), the symptoms subside spontaneously or after taking tincture of valerian, valocordin [5; 8].

Among patients of young age with a syndrome of minor structural anomalies of the heart there are persons with different combinations of anomalies. However in most adolescents the leading clinical signs are social maladaptation and reduced tolerance to physical activities. Almost in all cases there are complaints of cardialgia and a feeling of interruptions heart function [4].

Most scientists and medical doctors along with medication recommend also the use of a healthy lifestyle with limited physical activity, however, the method of using physical exercises to improve the physical condition of adolescents is not sufficiently developed.

**The Aim of the Research** is to study the effect of rationally dose-related physical exertion on the severity of the main symptoms of the disease and the physical condition of adolescents with minor structural cardiac abnormalities.

**Study Material and the Methods of Work.** The research was conducted at the laboratory of biomedical basis of physical education and sport, which is based on the Kherson Regional Center for Health and Sports Medicine.

During the 2016–2017 years 36 teenagers (20 boys and 16 girls) aged 14–15 years were physically rehabilitated. The occurrence of MSCA was confirmed by echocardiographic research and clinical implications of the disease.

Before the beginning of rehabilitation measures, a questionnaire was conducted for patients. The aim was to identify a subjective assessment of clinical manifestations of the disease on a five-point scale, to determine the tolerance to physical activity with bicycle ergometry and the index of physical condition (IPC) according to Professor O. P. Schepin. The somatic index (SI), pulmonary-somatic (PSI), cardio-somatic (CSI) and additionally podometry indices (PI) [2] were determined.

Fundamentally in determining the somatic index is the establishment of the degree of physical development of the individual by comparing his anthropometric characteristics (height, weight, chest circumference) with the gender constitution standard: I degree – good (or harmonious) physical condition; II degree – deteriorated (or disharmonious) physical condition; III degree – bad (or sharply disharmonious) physical condition. The somatic index was determined by converting the degree of physical condition into its index value in accordance with the table of genotype standards of physical condition: I degree – 1,0; II degree – 0,5; III degree – 0,25.

The pulmonary –somatic index was defined as the ratio of the vital capacity (VC) to the proper vital capacity (PVC) and was expressed with the numbers from 0 to 1. Where the real values (VC)/(PVC) more than 1, by default PSI = 1.

The proper vital capacity can be calculated using the regression equation:

$$PVC, (ml) = (40 \times \text{height in cm}) + (30 \times \text{weight in kg}) - 4400 (\text{men}); \quad (1)$$

$$PVC, (ml) = (40 \times \text{height in cm}) + (10 \times \text{weight in kg}) - 3800 (\text{women}). \quad (2)$$

Cardio–somatic index (CMI). The starting data for its calculation are the pulse rate and arterial pressure at rest, the individual's chronologic age and its anthropometric indices. It can be calculated using the regression equation:

$$CMI = \frac{700 - 3 \times PR - 0,8333 \times SBP - 1,6667 \times DBP - 2,7 \times CA + 0,28 \times BW}{350 - 2,6 \times CA + 0,21 \times H}; \quad (3)$$

Where: PR – is pulse rate, beats per minute, CA – is chronologic age, years; SBP – systolic blood pressure, mm of mercury; DBP – diastolic blood pressure, mm of mercury; BW – body weight, kg.; H – height, cm.

The cardio–somatic index has a set of values ranging from 0 to 1. With real values of KSI less than 1, KSI = 0, and with real values of KSI, greater than 1, KSI = 1.

The podometry index (PI) was calculated using a formula:  $PI = \frac{h \times 100}{L}$ ; (4)

Where h – is pile height – the distance from the floor to the upper surface of the navicular bone at 1,5 cm in front of the ankle joint, mm. L – is foot length – distance from the tip of the toe to the back of the heel, mm. The index of the normal arch of foot is in the range from 31 to 29, the mionectic arch of foot has a border from 29 to 25 and indicates flattening, and a value less than 25 characterizes a significant flat foot. Index values were converted to a similar value for other indexes from 0 to 1.

Then modified formula for determining the index of physical condition of adolescents was used:

$$PCI = 0,1 \times SI + 0,2 \times PI + 0,3 \times PSI + 0,4 \times CSI; \quad (5)$$

The values of the PCI from 0 to 1 were determined by 5 levels of physical condition: low (0–0,29), below average (0,3–0,49), average (0,5–0,69), above average (0,7–0,89) high (0,9–1,0) [2; 3].

The results obtained during the study were processed by methods of mathematical statistics.

During the course of physical rehabilitation of adolescents with MSCA the following means of physical education were used: general exercises of aerobic-anaerobic power capacity, including the usage of training devices; sports and applied exercises; action-oriented games; respiratory gymnastics; special physical exercises aimed at training the vestibular apparatus and orthostatic resistance; exercises on the formation and maintenance of correct posture and prevention of flat feet; quenching. It was highly recommended to do

morning hygienic gymnastics, special breathing exercises, procedures that promote hardening, autogenous training, self-massage on a daily basis. Once or twice a week at the day free from classes the dosed walking was recommended.

Aerobic-anaerobic physical activity was dosed individually, taking into account a certain tolerance to physical activity.

The method of physical rehabilitation of adolescents with MSCA consisted of three stages, each lasting from three to four months.

At the first stage of rehabilitation lasting 12–16 weeks, physical exercises of aerobic power were used mainly for group support with music background, duration and intensity of exercises contributed to the gradual retraction and adaptation of the body to dosed aerobic exercises.

These classes were held four times a week, the total duration of classes was 35–40 minutes, 40–50 % motor density was recommended. The control of the intensity of physical activity was carried out by the heart rate monitoring. The recommended heart rate was 45–50 % of the individually recommended heart rate, the average was 55–60 % and peak reached 70 %, but it was not recommended to exceed this threshold. At the end of the lesson, after the completion of the final part, the heart rate was calculated within five minutes of the recovery period. For determining the tolerance to physical activity the staged control was carried out at the end of the milestone.

At the second stage of physical rehabilitation, which lasted 12–16 weeks, the means and forms of influence on the painful process remained unchanged, but exercises on the simulators were added. Duration of classes was 40 minutes, motor integrity was 55–60 %. The gradual increase in the intensity of aerobic physical activity continued, the threshold heart rate equaled 50–55 % of the individually recommended heart rate, the average corresponded to 60–65 % and peak reached 80 %, but it was not recommended to exceed this threshold.

In the course of the training veloergometer exercises were applied, during which the load gradually increased until the heart rate peak was reached and maintained at that level for 3–5 minutes. Then the level of heart rate average gradually decreased, the total time of training on bicycle ergometer lasted 10–12 minutes.

At the end of the second stage, another milestone review of patients was conducted. On the basis of the results of the medical examination data on the functional state of the cardiopulmonary system and the evaluation of subjective manifestations of the disease, physical activity was planned at the third – the final stage of physical rehabilitation.

At the third stage, the duration of the class remains – 40 minutes, motor integrity was 60–65 %.

Physical exercises at the third stage of physical rehabilitation were even more intense, during the aerobic workout the threshold heart rate equaled 60 % of the individual recommended maximum, heart rate average was 70 %, and peak reached 80–90 %. In order to gradually adapt the body of patients to anaerobic stress during exercise on a cycling machine after reaching peak heart rate, adolescents maintained this intensity for 4–5 minutes. After that the load was reduced by 25 % and the patients performed spurt (pedaling with the maximum possible speed), the duration of which gradually increased from 5–8 seconds to 20–25 s [6].

At the end of the third stage of physical rehabilitation, a survey was conducted to identify subjective evaluation of the manifestations of the disease and in-depth medical examination with the definition of parameters of physical development, functional state of the cardiopulmonary resuscitation system, and the index of physical condition. To optimize individual exercises, adolescents were given individual «health recipes» that contained specific recommendations for observing rational motor regimes and healthy lifestyles [7]. The results of the study are shown in table 1.

At the beginning of rehabilitation index of the physical condition of boys and girls is defined as average, the boys' index is  $-0,52 \pm 0,007$  and the girls –  $0,51 \pm 0,006$ . After completing the course of physical rehabilitation, the index of physical condition increased up to  $0,70 \pm 0,001$  for boys, which corresponds to the indicator above the average, and to  $0,69 \pm 0,004$  for girls and is on the upper limit of the average index of physical condition. The analysis of the results showed that the increase in the index of physical condition occurred primarily due to an increase in pulmonary and somatic and cardio-somatic indexes, the increase of which is statistically significant.

**Dynamics of Indicators of Physical Condition of Adolescents with Minor Structural Cardiac Abnormalities**

Physical Condition of Adolescents	Year 2016	Year 2017	t	p
	Boys n=20			
Somatic index	0,67 ± 0,07	0,70 ± 0,06	0,61	> 0,05
Podometry index	0,61 ± 0,11	0,72 ± 0,01	1,38	> 0,05
Pulmonary–somatic index	0,50 ± 0,12	0,70 ± 0,11	2,12	< 0,05
Cardio–somatic index	0,45 ± 0,12	0,70 ± 0,10	2,09	< 0,05
Physical condition index	0,52 ± 0,007	0,70 ± 0,001	18,68	< 0,001
Subjective evaluation of manifestation of the disease	1,95 ± 0,13	3,15 ± 0,21	6,81	< 0,001
girls n=16				
Somatic index	0,65 ± 0,09	0,68 ± 0,08	1,42	> 0,05
Podometry index	0,56 ± 0,11	0,59 ± 0,10	0,97	> 0,05
Pulmonary–somatic index	0,44 ± 0,13	0,69 ± 0,12	2,16	< 0,05
Cardio–somatic index	0,50 ± 0,13	0,75 ± 0,11	2,17	< 0,05
Physical condition index	0,51 ± 0,006	0,69 ± 0,004	38,1	< 0,001
Subjective evaluation of manifestation of the disease	2,37 ± 0,16	3,0 ± 0,19	4,84	< 0,001

**Conclusions and Perspectives of Further Research.** Rationally planned and carried out measures of the physical rehabilitation of adolescents with minor structural cardiac abnormalities bring a vast improvement to the functional state of the cardiorespiratory system, reduce the severity and reduce the duration of the clinical symptoms of the disease. Prospects for further research we see in the development of methods of physical rehabilitation of children of junior school age, and adapted to the age of «recipes of health».

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