

The Functional State of the Cardiovascular System After the Application of Breathing Exercises

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Abstract

The health of the population is the economic potential of a developed country, so the preservation and promotion of public health is a priority now. The state of young people's health is of the greatest relevance, particularly the students' health, which is nowadays alarming for the country. The study aims to evaluate the effectiveness of the use of breathing exercises in the physical education of students with health problems on the functional state of the cardiovascular system. Evaluation of the effectiveness of the method of using breathing exercises according to A.N. Strelnikova's methodology and Greer Childers' "Bodyflex" in physical training with students with functional health disorders was based on the results of a comparative experiment conducted at the Department of Physical Education of the Moscow Polytechnic University. The results obtained in the course of the study convincingly prove that the experimental methodology based on the use of breathing exercises in physical education of students with health problems is effective and contributes to the improvement of the functional state of cardiovascular and respiratory systems. Moreover, the results of the study showed that the experimental technique has a positive impact on the well-being and academic achievements of the participants.

Keywords: Special medical group, Breathing exercises, Physical education, Training sessions, Students

INTRODUCTION

The health status of the younger generation is an important indicator of the development of a society. The purpose of physical education at university is the formation of the physical culture of the individual, their ability to use a variety of means of physical culture to preserve and strengthen their health, to increase the level of motor activity, as well as self-preparation for future professional activity.

According to the order of the Ministry of Health of the Russian Federation No. 514n dated August 10, 2017, based on the state of health, students are assigned to the following medical groups for physical education: main, preparatory, and special [1].

The main medical group (MMG) for physical education includes students without health and physical development disorders; with functional disorders that did not cause lagging behind their peers in physical development and physical fitness.

Students assigned to MMG are allowed to take classes in full according to the syllabus of physical education using preventive technologies, preparation, and passing tests of individual physical fitness.

The preparatory medical group (PMG) for physical education includes students who have morphofunctional disorders or

poor physical preparedness; who are at risk for the occurrence of diseases (pathological conditions); with chronic diseases (conditions) in the stage of persistent clinical and laboratory remission lasting at least 3-5 years.

Students assigned to this group are allowed to take classes in the physical education syllabus, provided that they gradually master a set of motor skills and abilities, especially those related to the increased requirements to the body, more careful dosing of physical activity, and the exclusion of contraindicated movements.

The special medical group (SMG) for physical education is divided into two subgroups: "A" and "B".

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The special subgroup “A” includes students with permanent health disorders (chronic diseases (conditions), congenital malformations, deformities without progression, in the compensation stage) or of temporal type; with physical development disorders requiring restriction of physical exertion.

Students assigned to this group are allowed to engage in recreational physical culture according to special programs (preventive and wellness technologies).

The special subgroup “B” includes students with permanent health disorders (chronic diseases (conditions) in the stage of subcompensation) and temporary health conditions, without pronounced well-being disorders.

Students assigned to this group are recommended to engage in physical therapy in a medical organization and do regular exercises at home according to the complexes assigned by physical therapists.

The data of the recent studies in physical culture, pedagogy, medicine indicate a decrease in the number of young people with a good level of physical development, physical fitness, and functional state [2-5]. According to the results of medical examinations, on average, more than 40% of students are enrolled in SMG, and 15-18% of those have an exemption from physical education for health reasons. The main reason for this is not only a decrease in motor activity but also a complication of the content of the educational process, an increase in neuropsychic tension in the educational and daily activities of students.

One of the most effective means of rationing the motor activity of students is physical education. The approximate syllabus on physical culture is aimed at engaging almost all students in educational training classes (UTC). The exception is made for the students who obtained either a permanent or a temporal exemption from practical physical education classes and are obliged to master theoretical material instead. The content of the classes of SMG students should primarily be aimed at improving health and maintaining high efficiency in the learning process. It is also suggested to use a variable part in an exemplary physical culture syllabus, which may include breathing techniques. It is assumed that the use of respiratory techniques in the process of physical education of SMG students will contribute to improving the functionality of the cardiorespiratory system and, as a result, to overall health improvement. At the same time, it should be noted that breathing exercises (BE), which contribute to improving the functional capabilities of the involved students, should include the following components:

- full breathing and interval hypoxia;
- variation and combination of breathing exercises performed in different modes, which will contribute to a comprehensive corrective effect on the vital systems of those involved. Thus, we singled out two breathing

techniques that meet the requirements, namely, A.N. Strelnikova's breathing gymnastics and the “Bodyflex” technique by Greer Childers.

MATERIALS AND METHODS

Participants

Evaluation of the effectiveness of the method of application of breathing exercises according to the method of A.N. Strelnikova and “Bodyflex” by Greer Childers at PT training sessions with students with functional health disorders was carried out based on the results of a comparative experiment conducted at the Department of Physical Education of Moscow Polytechnic University (MPU). It was attended by 267 1st and 2nd-year students assigned to a special educational department. Two groups were formed – an experimental one (EG, n=137) and a control one (CG, n=130). The CG students were engaged in the program of the subject “Physical culture and sports” devised by the teaching staff of the Department of Physical Education for the SMG. In the experimental group, the developed method with the use of breathing techniques was included in the work program of the department. The functional capabilities of the students participating in the experiment were tested at the beginning and the end of the experiment.

Procedure

The introduction of unconventional means of physical culture, in particular, respiratory techniques, into the process of physical education of SMG students helps to increase the motor activity and functional capabilities of vital body systems (CVS and RS) of the students with impaired health. In this regard, we have developed a methodology for the use of breathing exercises based on the method of A.N. Strelnikova and the “Bodyflex” system by Greer Childers for PT training in the SMG. The use of breathing exercises was combined with physical exercises aimed at improving physical development and fitness. Such exercises included: walking and running; total development exercises; exercises aimed at developing physical qualities; outdoor games and relay races of moderate intensity [6-9]. Exercises according to the methods of Strelnikova and Childers were not used simultaneously during a lesson, and therefore their application was based on alternation: during the first 12 classes in the first semester, students mastered the BE based on the method of Strelnikova, the last 12 classes in the first semester – according to the Greer Childer's method; in the 2nd semester, the mastered systems were applied strictly through one lesson, lasted 90 minutes and corresponded to the generally accepted three-part structure.

The preparatory part of the training session, following the recommendations of specialists developed for people with impaired health, was somewhat longer than the generally accepted one and lasted 20 minutes, in which walking exercises, total development exercises, and variable running were used [10-12]. The duration of the main part of the

training session was 50 minutes. It consisted of two parts: 30 min – doing breathing exercises based on one of the methods (either Strelnikova or Childers); 20 min – a variable part, alternately including either exercises for the development of physical qualities, or outdoor games and relay races of moderate intensity. In total, four sets of exercises were devised for the development of physical qualities lasting 10 minutes each – for the development of strength, endurance, speed, flexibility, and coordination. These complexes were compiled taking into account recommendations for students with impaired health and were included in the main part of the training session in various combinations once a week. For the second training during a week, games or relay races of moderate intensity were included in the variable part of the training session.

The final part of the training session, in accordance with the recommendations of specialists developed for people with impaired health, was somewhat longer than the generally accepted one and lasted 20 minutes [13]. The content of the final part of the training session consisted of sets of stretching exercises. Musical accompaniment was used in this part of the lesson. The content of the training sessions of the experimental methodology in a special medical group is presented in **Table 2**.

RESULTS AND DISCUSSION

Initially, we decided to compare the functional state of the subjects of MMG – 137 people and that of SMG – 130 people with functional disorders of the cardiovascular and respiratory systems (CVS and RS). The results obtained are presented in **Table 1**.

Table 1. Results of assessment of the functional state of the CVS and RS of students of various health groups (MMG n = 137; SMG n = 130)

INDICATORS	MMG	SMG
Resting heart rate (RHR)	unsatisfactory	unsatisfactory
Arterial tension	decreased SBP	decreased SBP increased DBP
Pulse pressure (PP)	normal	normal
systolic blood volume (SBV)	below normal	below normal
Minute blood volume (MBV)	normal	normal
Stange	good	good

Hench	good	satisfactory
orthostatic sample	good	unsatisfactory
Ruffier	good	satisfactory
Modified Harvard Step test	average	poor
Kerdo Vegetative Index (KVI)	balanced	balanced
Skibinsky Index	satisfactory	satisfactory

The level of functional state of CVS and RS was assessed by indicators: resting heart rate (RHR), blood pressure (BP), pulse pressure (PP), systolic blood volume (SOC), minute blood volume (MBV), Stenge and Gencha samples, orthostatic sample, Ruffier Sample, modified Harvard Step Test [14-16], Kerdo Vegetative Index (KVI), Skibinsky Index.

The conducted comprehensive study showed that at the student age, CVS disorders manifested, first of all, in a decrease in the level of physical performance, in the efficiency of the CVS functioning and the body's resistance to hypoxia, and the occurrence of hypotonic states and vegetative-vascular instability. These somatic features are found to a greater extent in the group of students with impaired health and have an impact on some aspects of life. The survey shows that SMG students are more susceptible to catching a cold, and often suffer from lack of appetite and sleep disorders. They are less likely to spend time outdoors and do physical activity.

Generalization of the results of the diagnosis of the functional state of the CVS allows us to conclude judging by the majority of the examined indicators, that after attendance of the experimental classes, the students of the EG showed significant positive changes.

In particular, the majority of subjects in the EG economized myocardial activity, improved aerobic capabilities of the body, increased physical performance, improved oxygen transport capabilities of the body, and the general condition of the cardiorespiratory system. At the same time, the final indicators of heart rate at rest, diastolic blood pressure, pulse pressure, systolic blood volume, Stange and Gencha samples, as well as the modified step test in the EG are significantly better than in the CG. Interestingly, in the CG, no significant changes were detected in any of the examined indicators of the functional state. The results obtained are presented in **Table 3** and **Figure 1**.

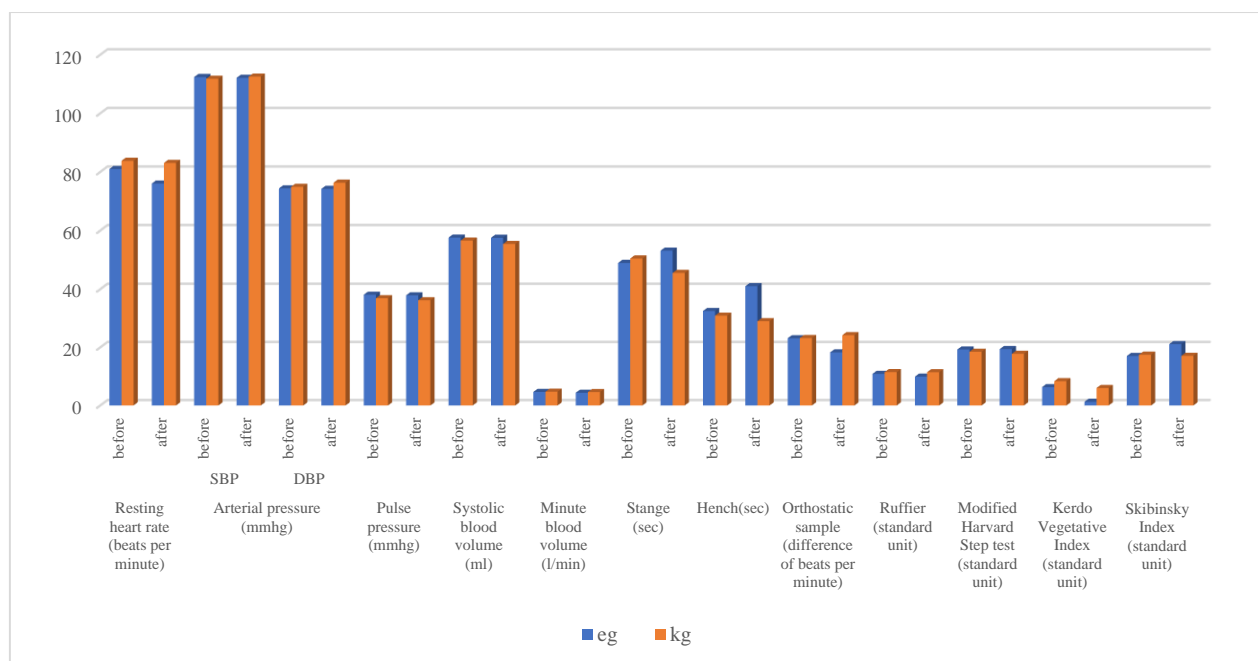


Figure 1. Functional state of the CVS of eg students kg before and after the experiment

Table 2. Content of training sessions on experimental methods in a Special medical group

Part of the lesson	Duration	Content	Types of activities
<i>Preparatory part (warm-up)</i>	20 min	<ul style="list-style-type: none"> □ organization of attention □ heart rate measurement at rest □ preparation of the body to perform exercises in the main part of the lesson 	<ul style="list-style-type: none"> □ walking (on toes, heels, external and internal arch of the foot, etc.), slow interval running, total □ development exercises (on the spot, in motion, with gymnastic sticks, in pairs, with balls, etc.)
<i>Main part</i>	30 min	<ul style="list-style-type: none"> chest mobility increase □ increase of vital lung capacity □ development of respiratory muscle strength □ learning to control breathing □ increasing the body's resistance to hypoxia and hypercapnia □ stabilization and reduction of heart rate at rest □ improvement of the "pumping" function of the heart muscle □ blood pressure stabilization 	<p>Breathing exercises (method of A.N. Strelnikova)</p> <p>"Palms", "Ears", "Cat", "Pump", "Shoulder straps", "Pendulum head", "Head turns", "Rolls", "Big pendulum", "Hug your shoulders", "Steps", "Monkey", "Monkey lying down" "Socks-heels"</p> <p>Breathing exercises (Method of «Body flex» by Greer Childers)</p> <p>"Lion", "Ugly face", "Side", "Back leg Extension", "Seiko", "Diamond", "Boat", "Cat", "Bretsel", "Hamstrings", "Holding crunch", "Scissors"</p>
<i>complex training</i>	20 min.	<ul style="list-style-type: none"> □ development of physical qualities (strength, flexibility, speed, coordination) 	<ul style="list-style-type: none"> □ exercise complexes in the gym on gym mats, with fit balls, dumbbells, gymnastic sticks, in pairs □ outdoor and sports games of low and medium intensity (table tennis, badminton) □ training on simulators □ tasks for coordination and attention
<i>Final part (hitch)</i>	20 min	<ul style="list-style-type: none"> □ muscle relaxation and respiration recovery □ heart rate measurement after load 	<ul style="list-style-type: none"> □ relaxation exercises □ drill exercises

Table 3. Functional state of the CVS of EG students (n = 137), KG (n = 130) before and after the experiment

Indicators	Order of tests	ЭГ		P ЭГ-КГ	КГ	
		M ± m	P		M ± m	P
Resting heart rate (beats per minute)	before	81,0±2,50	*	***	83,80±2,49	**
	after	76,03±1,70			83,07±2,37	
Arterial pressure (mmHg)	SBP	before	112,39±1,44	**	111,80±1,58	
		after	112,12±0,75		112,53±2,05	
	DBP	before	74,39±1,52	***	74,93±1,63	**
		after	74,23±0,67		76,33±1,01	
Pulse pressure (mmHg)	before	38,08±1,64	**	**	36,87±1,40	*
	after	37,88±0,84			36,20±1,76	
Systolic blood volume (ml)	before	57,59±1,56	**	***	56,58±1,44	**
	after	57,53±0,73			55,42±1,10	
Minute blood volume (l/min)	before	4,66±0,19			4,75±0,18	
	after	4,37±0,11			4,62±0,18	
Stange (sec)	before	48,96±2,90		*	50,47±2,90	*
	after	53,14±3,41			45,54±2,49	
Hench(sec)	before	32,50±2,50	*	*	30,89±1,71	*
	after	41,03±1,69			28,98±2,01	
Orthostatic sample (difference of beats per minute)	before	23,12±3,89			23,20±2,49	
	after	18,27±3,08			24,18±3,81	
Ruffier (standard unit)	before	10,87±1,04	**		11,49±0,67	**
	after	9,92±0,67			11,42±0,71	
Modified Harvard Step test (standard unit)	before	19,25±0,66		*	18,45±0,49	*
	after	19,39±0,93			17,75±0,43	
Kerdo Vegetative Index (standard unit)	before	6,31±3,23	**		8,340±3,44	**
	after	1,26±2,21			6,02±2,80	
Skibinsky Index (standard unit)	before	17,02±1,34	*		17,46±1,36	
	after	21,11±1,71			17,07±1,46	

* - differences are significant by Student's criterion (p≤0.05)

** - differences are significant by Fisher's criterion (p≤0.05)

*** - differences are significant by Student's and Fisher's criteria (p≤0.05)

Besides, it was found that EG students became more successful in their studies after a year of experimental classes. The average score for all exams in the session was calculated for each subject. Further, the average group scores before and after the experiment were calculated based on the aggregate of the average scores of the entire sample, which then were compared with each other. Before the experiment, the average scores of EG students ranged from 3.0 to 5.0 points, and the average score in the group was 4.05 ± 0.1 . After the experiment, the average scores of the students were in the range of 3.2 to 5.0 points, and the average score in the group was 4.14 ± 0.09 (the differences are not significant). The percentage of grades received by the subjects during the session has changed for the better. So, after the pedagogical experiment, the number of exams for which students received grades “good” and “excellent” increased. Accordingly, the number of “satisfactory” grades decreased. Most of the EG students in both summer sessions passed the tests and exams

on time. Nevertheless, the number of students who were certified outside the established deadlines decreased after the experiment: 30.8% before the experiment, and 23.1% after.

CONCLUSION

The data obtained allow us to conclude that the developed methodology for the use of breathing exercises in physical education with SMG students contributes to the positive correction and improvement of the functional state of the cardiovascular and respiratory systems. We also found a positive effect of the experimental classes on the well-being and academic achievements of the subjects.

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ETHICS STATEMENT: All procedures met the ethical standards of the 1964 Declaration of Helsinki. Informed consent was obtained from all parents of the children included in the study.

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