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Original Article

Respiratory gymnastics for students with cardiological diseases

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Abstract.
Purpose: to give scientific justification to the technique of performing breathing exercises by students with cardiological diseases.
Material: Female students of 1-2 courses (n=61) participated in the experiment. All females had cardiological diseases: vegetovascular dystonia, hypotonia, hypertension, heart arrhythmia, insufficient blood circulation. The following groups created: experimental (n=28) and control (n=33). They trained for 90 min (2 times per week). The annual volume of training for each group was 68 hours.
Results: Females of the experimental group had significant positive changes according to the majority of indicators: economization of myocardium activity, oxygen transportation opportunities of an organism, aerobic opportunities of an organism, physical working capacity. It was also determined more significant positive changes: vital capacity, strength, flexibility, coordination. It is confirmed the expediency of systematic application of the breathing exercises with a full breath and interval hypoxia.
Conclusions: It is expedient to perform breathing exercises on the classes of the subject "Physical culture" with the students suffer from cardiological diseases.
Keywords: health, female students, cardiological diseases, breathing exercises, respiratory gymnastics.

Introduction.

The most relevant tasks for the system of physical training nowadays are: increase in general level of somatic health of students; optimization of physical activity of students; development of the need for systematic physical culture training (ideally – independent) in students; development of the most attractive techniques of physical activity for students (Bliznevsky et al., 2016; Kondakov, Kopeikina, & Balysheva, 2016; Korobeynikov, Korobeynikova, Iermakov, & Nosko, 2016). Recently the problem of preservation, strengthening, and formation of the health of the young generation is relevant for every country. The quantity of cardiological, nervous, mental and oncological diseases constantly increased. Nowadays the young generation more often suffers from these diseases. Researches show that the number of students with the deterioration of health is 40-45% on average. 15-18% of students had the medical excuse of physical culture training (Balysheva, Gorelov, & Rumba, 2011; Kopeikina, Balysheva, & Bogoeva, 2013; Osipov et al., 2017). The decrease in physical activity, computerization of educational process, increase in psychological loads in educational and daily activity are the main reasons for the decrease in the level of student's health.

The experts consider the physical activities in the moderate mode as an important part in the improvement of young people with cardiological diseases. It is recommended to perform the exercises which promote activation of blood circulation: cyclic and acyclic aerobic exercises, including breathing exercises (Gorelov, Rumba, & Peremyshlennikova, 2008; Bogoeva & Kopeikina, 2011; Podrigalo, Iermakov, Rovnaya, Zukow, & Nosko, 2016). Other authors determine the need for pedagogical control of physical training exercises (Kozina et al., 2016a, 2016b; Ivashchenko et al., 2017). It is important to note that we didn't reveal the experimental data about the systematic application of breathing exercises by students with cardiological diseases. There are recommendations about the application of breathing exercises in special literature. However such recommendations aren't concretized on nosology and are only fact-finding (Kondakov et al., 2016; Andres, 2017; Koryahin, Blavt, & Stadnyk, 2017).

We have studied long-term experience of the application of physical culture means for correction of a functional condition of the people suffer from cardiological diseases. The most effective among the widespread systems of breathing exercises revealed. The analysis of literature concerning the physiological influence of breathing exercises on cardiovascular system has allowed to draw a conclusion that breathing exercises are the powerful tool of organism's improvement (Symons, Morley, McGuigan, & Elie, 2013; Kondakov, Kopeikina, Balysheva, Usatov, & Bocharova, 2016; Kolokoltsev, Iermakov, & Prusik, 2018). It is shown in normalization of

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the heart activity and the blood circulatory system. Authors determined that existence of various techniques allows to choose the breathing exercises individually depending on the purpose of physical training exercises.

Study of physiological mechanisms of breathing exercises' influence on the functional condition of youth has shown that their positive influence on the cardiovascular system defined by application of full breath and an interval hypoxemic training. It promotes the development of adaptation reactions. The full breath training is the basis of the majority of the known systems of breathing exercises. Therefore any of them can be applied to the performance of this component of a breathing training. One of the first evidence-based techniques of the interval hypoxia is the technique of strong-willed stop of a deep breath (Burenkov, 1990). The efficiency of such technique proved in the treatment of bronchial asthma and other cardiorespiratory diseases. The paradoxical gymnastics also belongs to a number of the most known and widespread applied techniques of breathing exercises of hypoxemic nature (Schetinin, 2006). This technique has the medical effect on circulatory collapse and hypertension. Nowadays the great popularity has the technique of "Body flex" of hypoxemic character. The basis of a technique is ancient Oriental breathing practicing (Childers, 2007; Fedyniak & Mytskan, 2016). The positive impact of "Body flex" technique shown: increase in physical working capacity; general improvement of a functional condition of the cardiorespiratory system. The technique also promotes body weight reduction (Kopeikina et. al., 2013; Lochbaum, Prosoli, & Barić, 2017).

According to experts' opinion, hydrotherapeutic procedures promote the improvement of blood supply of heart and muscular tissue. It increases stressful impact in a cardiac muscle and improves aerobic opportunities of an organism (Kopeikina, Drogomeretsky, Kondakov, Kovaleva, & Iermakov, 2016; Drogomeretsky, Kopeikina, Kondakov, & Iermakov, 2017).

The analysis of special literature has allowed to systematize the systems of the breathing exercises applying full breath and interval hypoxia:

- the technique of K.P. Buteyko has hyperventilation and hypercapnic nature (exercises performed with a breath-holding without combination with physical exercises) (Burenkov, 1990);
- the technique of A.N. Strelnikova has hyperventilation and hypercapnic nature (exercises performed with active inhale, without breath-holding, in a combination with dynamic physical exercises) (Schetinin, 2006);
- the technique of G. Childers has hyperventilation and hypercapnic nature (exercises performed with an active exhalation, on a breath delay, in combination with static and dynamic physical exercises) (Childers, 2007).

Such approaches emphasize the relevance of our research. It testify to necessity of development of sports and improving technologies which promote: development and improvement of basic physical qualities; formation of basic motor skills; promotion of health; providing optimum conditions of activity of functional systems of student's organism (Ahmad et al., 2010; Grachev & Gavrishova, 2013; Kondakov, Kopeikina, & Usatov, 2016; Kriventsova et al., 2017). We performed the theoretical analysis and made a synthesis of literary data concerning the problem of violations' prevention in a condition of the cardiovascular system of students. It is proved the existence of a problem situation (Ahmad et al., 2010; Adyrkhaev, 2016; Ivashchenko et al., 2016; Kozina, Iermakov, Bartík, Yermakova, & Michal, 2018). The relevance of a problem also defined by the acute need of development and scientific justification of improving technologies which directed to a certain nosological group.

The purpose of the research is to give scientific justification to a technique of breathing exercises' application on classes «Physical culture» with the students having cardiological diseases.

Material and methods

Participants. Female students of 1-2 courses (n=61) participated in the experiment. All females had cardiological diseases: vegetovascular dystonia, hypotonia, hypertension, heart arrhythmia, insufficient blood circulation. The tests were applied for evaluating the functional condition and physical fitness (Dubrovskij, 2005; Shiian et al., 2005).

The research related to human use has been complied with all the relevant national regulations, institutional policies and in accordance with the tenets of the Helsinki Declaration (WMA Declaration of Helsinki, 2016). The study protocol was approved by the Ethical Committee of University.

Organization of a research.

Female students of the experimental group (EG, n=28) trained according to the developed technique. The basis of training of females from the control group (CG, n=33) was the program for students with health problems (without division of students according to nosology). The training was 90 min 2 times per a week. The annual volume of training was 136 hours.

The basis of the developed technique was breathing exercises by Strelnikova and Childers techniques (Schetinin, 2006; Childers, 2007). Breathing exercises by K.P. Buteyko's technique (Burenkov, 1990) included in the content of classes as an additional tool for relaxing and faster recovery of an organism after the performance of physical activity. Breathing exercises applied in a complex with the physical exercises directed to the improvement of physical development and physical fitness.

The exercises by Strelnikova's and Childers' techniques didn't perform in one training. The training based on the principles of rotation. In the first semester, students mastered breathing exercises in the following

order: first 12 training according to Strelnikova's technique; the last 12 training according to Childers' technique. In the second semester, the exercises rotated through the one training. Improving swimming intended for 8 training and performed two times: the first semester – between the study of exercises by Strelnikova's technique and exercises by Childers' technique; at the beginning of the second semester – for the purpose of the gradual increase in load after winter vacation of students.

Preparatory part of training was a little longer than standard. It lasted 20 min (training in the gym) and 10 min (training in the pool) (Balysheva et al., 2011; Bartnovskay et al., 2017). Training also included rotation of run and walk. The average walk rate recommended. The speed of run chosen individually. In deterioration of health, the run replaced with the fast walk.

The main part of training (50 min in the gym, 30 min in the pool) consisted of two parts: 30 min of breathing exercises by one of techniques (either Strelnikova, or Childers); 20 min of variable part (exercises concerning development of physical qualities, outdoor games and relays).

The final part of training was a little longer than standard. It lasted 20 min (training in the gym) and 5 min (training in the pool) (Balysheva et al., 2011). The content of a final part of training was in two variants which rotated through one training: the first variant – 10 min for breathing exercises according to Buteyko, 10 min for exercises for exit from a method («the Tibetan recipe of longevity», asanas – «snake», «stomach suction», relax); the second variant – 20 min for a set of exercises in flexibility. All tasks were performed slowly in combination with equal breath under music.

Statistical analysis: the received data were processed with the help of licensed electronic tables Excel (2010). We found indicators of descriptive statistic (mean arithmetic, standard deviation and error of mean value). Confidence of differences was determined by Student's t-test (Fisher's test) and differences were considered confident at $p<0.05$.

Results

At the beginning and at the end of experimental training

It was performed testing for identification of differences in a functional condition of the cardiovascular system, physical development, physical fitness, somatic health (Tab. 1, 2).

Table 1. The functional condition of the cardiovascular system of females of EG (n=28), CG (n=33) before and after the experiment

Indicators		Groups	before M ± m	after M ± m	P	P EG-CG
Resting heart rate (bpm)		EG	81.1±2.51	76.04±1.71	*	***
		CG	83.80±2.49	83.07±2.37		
Arterial tension (mm Hg)	systolic	EG	112.30±1.45	112.13±0.76	**	
		CG	111.80±1.58	112.53±2.05		
	diastolic	EG	74.37±1.50	74.25±0.67		***
		CG	74.93±1.63	76.33±1.01		
Tests	Stange (s)	EG	48.95±2.91	53.13±3.42		*
		CG	50.47±2.90	45.54±2.49		
	Hench (s)	EG	32.49±2.49	41.11±1.68	*	*
		CG	30.89±1.71	28.98±2.01		
	Ruffier (c.u.)	EG	10.86±1.03	9.91±0.68	**	
		CG	11.49±0.67	11.42±0.71		
	Orthostatic difference (bpm)	EG	23.13±3.87	18.26±3.07		
		CG	23.20±2.49	24.18±3.81		
Index	Kerdo (c.u.)	EG	6.32±3.24	1.27±2.22		
		CG	8.340±3.44	6.02±2.80		
	Skibinski (c.u.)	EG	17.03±1.35	21.12±1.72	*	
		CG	17.46±1.36	17.07±1.46		
Volume of blood	Minute (l/min)	EG	4.64±0.21	4.38±0.12		
		CG	4.75±0.18	4.62±0.18		
	systolic (ml)	EG	57.59±1.56	57.53±0.71	**	***
		CG	56.58±1.44	55.42±1.10		
Pulse pressure (mm Hg)		EG	38.08±1.62	37.88±0.82	**	**
		CG	36.87±1.40	36.20±1.76		
Modified step-test (c.u.)		EG	19.24±0.67	19.38±0.94		*
		CG	18.45±0.49	17.75±0.43	**	

Note.

* - it is significant (Student t-test, $p \leq 0,05$)

** - it is significant (F-test, $p \leq 0,05$)

*** - it is significant (Student-Fischer test, $p \leq 0,05$)

The females of experimental group on the majority of functional condition's indicators of the cardiovascular system had significant positive changes after training. The female students had the economization of myocardium activity. It was also determined improvements in oxygen transport opportunities of an organism; aerobic opportunities of an organism increased; the physical working capacity increased; also the general condition of the cardiorespiratory system improved. The females of experimental group improved the following indicators: pulse at rest; diastolic arterial blood pressure; pulse pressure; the systolic volume of blood; Shtange and Genchi tests; indicators modified a step-test. The females of the control group of had no significant changes in indicators of a functional condition of the cardiovascular system (tab. 1).

The females of the experimental group had more positive changes in the majority of indicators of physical development and physical fitness than females in the control group. In females of experimental group significantly increased the following indicators: mobility of a thorax; vital capacity of lungs; force; flexibility; coordination. The females of control group improved indicators of force and flexibility. Total results of strength, flexibility, coordination in the experimental group were significantly better than in control group (tab. 2).

Table 2. Physical development and physical fitness of females of EG (n=28) and CG (n=33) before and after the experiment

Indicators		Groups	before M ± m	after M ± m	P	P EG-CG
Body length (cm)		EG	165,23±1,34	165,73±1,15		
		CG	164,38±1,29	164,77±1,25		
Body weight (kg)	actual	EG	58,63±1,69	58,06±1,67		
		CG	58,35±2,06	57,47±1,78		
	optimal	EG	60,48±0,95	60,10±0,90		
		CG	59,34±1,29	59,91±1,24		
Circumference (cm)	waist	EG	69,54±1,34	68,73±1,35		
		CG	69,50±1,65	68,93±1,49		
	hip	EG	96,00±1,20	95,96±1,33		
		CG	96,33±1,35	96,40±2,47		
Chest rise (cm)		EG	5,10±0,34	5,98±0,35	*	
		CG	5,60±0,28	5,57±0,30		
Vital capacity (l)	actual	EG	2,76±0,13	2,97±0,88	**	
		CG	2,84±0,11	3,00±0,12		
	optimal	EG	3,69±0,55	3,70±0,47		
		CG	3,64±0,57	3,66±0,55		
Bench bend (cm)		EG	6,81±1,02	10,85±0,76	*	**
		CG	7,90±0,84	8,77±1,15	**	
Dynamometry (daN)	right hand	EG	22,23±0,80	24,31±1,30		
		CG	24,40±0,54	23,50±0,69		
	left hand	EG	22,10±0,99	23,04±1,14		
		CG	22,67±0,51	22,50±0,85		
Push-ups (times)		EG	3,04±0,84	6,50±0,65	*	**
		CG	4,60±0,91	6,23±1,22	**	
Romberg test (s)		EG	9,68±1,66	17,96±3,31	***	*
		CG	11,66±1,49	10,52±1,27		
Coordination coefficient		EG	6,82±0,75	3,78±0,20	*	*
		CG	6,96±0,67	6,38±0,56		

Note.
* - it is significant (Student t-test, $p \leq 0,05$)
** - it is significant (F-test, $p \leq 0,05$)
*** - it is significant (Student-Fischer test, $p \leq 0,05$)

The analysis of somatic health indicators (according to Apanasenko's technique) revealed that females of the experimental group had significant changes according to 5 indicators of 5: aerobic opportunities of an organism and physical working capacity increased; the reaction of the cardiovascular system to moderate load became less expressed; the general level of somatic health increased. In control group, aerobic opportunities of an organism improved. Aerobic opportunities of an organism and time of heart rate recovery after moderate load in females of the experimental group is significantly better than in females of the control group (tab. 3).

Table 3. Evaluation of somatic health of females of EG (n=28) and CG (n=33) before and after the pedagogical experiment

Indicators		Groups	before index M ± m	points M ± m	after index M ± m	points M ± m	P	P EG-CG
Index	body mass (by Quetelet)	EG	17,70±0,50	-1,15±0,18	17,50±0,50	-1,19±0,17		
		CG	17,73±0,60	-1,20±0,19	17,43±0,50	-1,20±0,19		
	strength	EG	62,79±3,84	1,62±0,32	58,43±2,55	1,62±0,26		
		CG	63,07±2,10	2,20±0,23	44,40±1,88	0,10±0,24		
	vital	EG	48,54±2,95	1,12±0,34	52,08±1,89	1,54±0,29	**	
		CG	49,70±2,31	1,30±0,26	52,10±1,68	1,53±0,27		
	Robinson	EG	91,30±3,49	0,08±0,23	85,23±1,98	0,31±0,18	**	***
		CG	93,60±2,90	-0,17±0,19	93,90±3,56	-0,23±0,26		
Time of pulse recovery after 20 squats in 30 s (min)		EG	2,05±0,38	1,27±0,40	1,16±0,06	4,0±0,36	*	***
		CG	2,00±0,06	1,50±0,45	1,46±0,07	2,40±0,41		
Totals		EG	2,92±1,48		6,27±1,25		*	*
		CG	3,63±1,31		2,60±1,35			
Health level		EG	low		below average			
		CG	below average		low			

Note.
* - it is significant (Student t-test, $p \leq 0,05$)
** - it is significant (F-test, $p \leq 0,05$)
*** - it is significant (Student-Fischer test, $p \leq 0,05$)

We have conducted additional researches for evaluation of influence extent of experimental technique. It is confirmed the positive influence of experimental training. It found out that health and mood of female students changed for the better.

The females of the experimental group in self-checking diaries noted: improvement of a dream and appetite; increased interest in active recreation and independent physical culture training; increase in intellectual working capacity; decrease in the number of uncomfortable conditions which connected with the available cardiovascular violations. Also, some females noted that they began to perform independently exercises according to Strelnikova and Childers system. Two females even involved elder relatives in performing Childers' technique.

Discussion

The carried theoretical analysis and synthesis of literary data proves the existence of a problem situation. Scientists, physicians and experts in the field of physical culture given the description to a set respiratory the technician and technologies of their application. However, there are discussions nowadays concerning perform of special breathing exercises: their advantages, disadvantages or neutrality.

In other research done the fullest retrospective analysis of known respiratory techniques (Krestovnikov, 1929), which the author compared to own experimental data. The author drew a conclusion that breathing exercises can promote the formation of a certain breath rhythm; it is necessary to apply this or that type of breath performing physical exercises.

In the majority of researches authors hold the opinion concerning importance of training of the person in full breath and its any regulation (Szabo & Kocsis, 2017; Tavares, de Paula Vidigal, Garner, de Abreu, & Valenti, 2017; Cernes & Zimlichman, 2017; Todd, Walsted, Grillo, Menzies-Gow, & Hull, 2018). At the same time in special literature, there are a large number of results of the experimental studies demonstrating the advantage of a hypoxia (Gorelov & Rumba, 2011).

It conducted earlier researches of hypoxemic training systems in the educational process. So Merkulova E.A. and Chemodanova F.H. (Merkulova & Chemodanova, 2008) established the fact of significant improvement of mass and growth ratio in female students as a result of regular training "Body flex" gymnastics. Varavina E.N. et al. (Varavina, Bat-rak, & Dakal, 2009) successfully applied this technique to increase in resistance of students' organism to stress. Authors have noted additional effects of training: improvement of gas exchange and ventilation of lungs; removal of spasms of bronchial smooth muscles; improvement of intestinal peristalsis. The research conducted by us completes the experimental data obtained by authors.

Conclusions

Thus, the obtained data allow to draw a conclusion that the developed experimental technique promotes positive changes in a functional condition of the cardiovascular system. It promotes the increase in the general

level of students' somatic health. It was also determined the positive impact of experimental training on health and mood. The conducted researches confirmed our hypothesis and proved expediency of purposeful systematic application of the breathing exercises including full breath and interval hypoxia. Such exercises are recommended to perform in physical culture training by students having cardiological diseases. It will allow to increase the level of students' health.

Conflict of interests

The author declares that there is no conflict of interests**.**

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