

Publication date: 01.09.2021

DOI: 10.51871/2588-0500\_2021\_05\_03\_3

UDC 796

## SCIENTIFICALLY METHODOLOGICAL COMPLEX OF RESPIRATORY TRAINING DEVICES FOR REHABILITATION OF THE CARDIOVASCULAR AND RESPIRATORY SYSTEMS DURING AND AFTER THE PANDEMIC

L.A. Zelenin<sup>1,2</sup>, V.D. Panachev<sup>1,2</sup>

<sup>1</sup>Perm' National Research Polytechnic University, Perm', Russia

<sup>2</sup>Perm' Military Institute of the National Guard Troops of the Russian Federation, Perm', Russia

**Key words:** respiratory training devices, pandemic, respiratory system studies, students.

**Annotation.** The purpose of this study is to examine and justify the effect of the developed respiratory training devices using non-traditional health-improving respiratory technologies on the process of improving the state of health of students, their physical fitness in the functional state of respiration with a further development of the competence approach during the pandemic. The conducted studies showed that the lung capacity (LC) increased by  $115,38 \pm 35,45$  ml; the breath-holding test on inhale increased by  $7,13 \pm 3,21$  s; the breath-holding test on exhale increased by  $3,21 \pm 1,53$  s; the heart rate (HR) decreased by  $2,79 \pm 1,35$  beats/min; the thoracic mobility increased by  $2,59 \pm 1,73$  cm. Results of the questionnaire showed that the respiration process and the total state of the organism have positively improved. Following data was registered in students, who engage in freestyle wrestling in the Perm' National Exploratory Polytechnic University sports group: the LC increased by  $447,51 \pm 87,51$  ml; the breath-holding test on inhale increased by  $19,25 \pm 7,32$  s; the breath-holding test on exhale increased by  $11,33 \pm 4,35$  s; the HR decreased by  $5,36 \pm 3,13$  beats/min; the thoracic mobility increased by  $9,32 \pm 3,27$  cm. The questionnaire data of this group showed that the respiration process and the total state of the organism have also positively improved.

**Introduction.** Respiration and lung health represent the human's wellbeing at any age. Currently, more than 235 million people are diagnosed with bronchial asthma, and the whole world suffers from COVID-19. The main evolutionarily and historically studied function of the lungs is the gas exchange function. The second function is the immune function. The lungs are the most powerful part of the immune system, which is also the most vulnerable organ. The lungs protect

airways from viruses, bacteria and other dangerous organisms and particles. They also suspend a large amount of particulates per day, which are filtered by respiration organs [1]. Physiologists have calculated that the lungs filter about a bucket of dirt every day. Today there is a large number of non-traditional health-improving respiratory technologies, some of which were examined by us and used on physical culture classes in order to influence health improvement and increase the total functional state of students' health [2-5].

The study's relevance:

1. On social level: between the need of society and the government to preserve and improve physical, mental, professional and social health using individual health-improving respiratory practices with simple developed training devices, increasing the performance of the whole country's population, forming the competence of working with breathing and insufficient use of respiratory practices and creation of respiratory training devices, impacting effectively the organism of sick and healthy people with further development of the competence-based approach during the COVID-19 pandemic.

2. On practical level: between the high relevance of an ability to gain knowledge on implementing health-improving respiratory process by healthy and sick people, forming competence, and the relatively low level of their formation among population in acquiring scientifically methodological health-improving respiratory knowledge and their application using the developed respiratory training devices.

3. On scientifically methodological level: between the high relevance of physical culture and health-improving motivation of students, the respiratory system and insufficient scientific exploration of the substantial organizational and methodological support of the effective solution for health-improving respiratory practices with training devices in the physical culture area, theory and methods of health-improving physical culture and in medicine.

In accordance with the relevance and formed contradictions, we revealed the study's issue in a form of a following question: what are pedagogical, substantial organizational and methodological features of motivation to increase the effectiveness of the respiratory system's rehabilitation during physical activity and the competence-based responsibility for your own health using the developed training devices, ready to improve at any stage of the process of acquiring the competence-based approach in the fight against the pandemic?

Ideas about the issue's relevance, the degree of its development, content of formed contradictions and the specified issue in the scientifically methodological and special literature allowed forming the study's purpose, which can examine and justify the effect of the functional role in the formation of competence using

respiratory training devices with non-traditional health-improving respiratory gymnastic technologies on the process of improving the state of health of students, their physical fitness in the functional state of respiration with further development of the competence-based approach during the pandemic.

Main tasks of the study:

1. Analysis and assimilation of scientifically methodological and special literature on examined respiratory technologies when forming the competence;
2. Study and analysis of the effect of health-improving respiratory practices on the process of improving the respiratory system when implementing the competence-based approach;
3. To develop and create a set of training devices, modelling conditions in the respiratory system for breath holding on inhale, on exhale and on pause;
4. To develop the technology of the adjoined adoption of various respiratory cycles using the set of respiratory training devices and test the effectiveness of its implementation in physical culture classes and independent workout.

The study's novelty:

1. We revealed pedagogically psychological, methodological and theoretical basics of the developed and created training devices, forming an artificially managed environment, which modulates respiratory practices during physical culture training classes, actively influencing the process of health improvement of students.
2. We developed and tested original training devices, which improve the respiration system and allow modelling conditions of health-improving classes.
3. Biomechanical requirements for performing static and dynamic exercises in the artificial environment conditions were defined.
4. We also established a positive relation between improving of health of students and the performance of the set of the developed respiratory exercises on training devices during training classes and individual workouts.
5. An effective technology of forming health-improving exercises for students during training classes and independent workouts, as well as teaching breathing techniques on training devices, was developed and tested.

**Methods and organization.** The scientific pedagogical experiment was carried out in 2020-2021 in the Department of Physical culture of the Perm' National Exploratory Polytechnic University (PNEPU). 1-3 year students of the Mining and Oil Faculty (918 people), 1-3 year students of the special medical group (45 people) and students, who engage in freestyle wrestling (25 people) participated in the study.

During physical culture classes, we noticed that most students are not able to follow the curriculum of physical culture classes. They do not keep up with the

running training (weak endurance), have underdeveloped speed abilities, strength capabilities and low performance of the respiratory system. In order to improve and develop the respiratory system, we used a special set of health-improving respiratory practices at the beginning and at the end of the class.

Table

Set of exercises for the respiratory and cardiovascular system within the process of structuring respiration for the aerobic endurance

№	Content of exercises	Load performance
1.	Original stance – normal standing position. The inhale is performed chestful through both nostrils with a 10 s hold on inhale. Then the person exhales and performs the exercise again.	Do 5 sets 10 s each
2.	Original stance – normal standing position. The same exercise, but performed fast.	Do 5 sets 10 s each
3.	Original stance – normal standing position. The inhale is performed chestful through the nasal cavity. Then the person exhales with a 10 s hold.	Do 5 sets 10 s each
4.	Original stance – normal standing position. The inhale is performed chestful through the nose with a 10 s hold on inhale. Then the exhale is made till the end with a 10 s hold.	Do 5 sets 10 s each
5.	Original stance – normal standing position. The inhale is performed chestful through the left nostril, the right nostril is closed by the right index finger, with a 10 s hold. Then the person exhales and performs the exercise again.	Do 5 sets 10 s each
6.	Original stance – normal standing position. The same exercise, but performed fast.	Do 5 sets 10 s each
7.	Original stance – normal standing position. The inhale is performed chestful through the right nostril, the left nostril is closed by the left index finger, with a 10 s hold. Then the person exhales and performs the exercise again.	Сделать 5 с Do 5 sets 10 s each
8.	Original stance – normal standing position. The same exercise, but performed intensively.	Do 5 sets 10 s each
9.	Original stance – normal standing position. The inhale is performed chestful through the nasal cavity with a 5 s hold on inhale. Then the person exhales into the 1 mm 32 cm tube with a 5 s hold on exhale.	Do 5 sets 5 s each
10.	Original stance – normal standing position. The inhale is performed chestful through the left nostril with a 5 s hold on inhale, the right nostril is closed by the right index finger. Then the person exhales through the mouth into the 1 mm 32 cm tube with a 10 s hold on exhale.	Do 5 sets 10 s each
11.	Original stance – normal standing position. The inhale is performed chestful through the right nostril with a 5 s hold on inhale, the left nostril is closed by the left index finger. Then the person exhales through the mouth into the 1 mm 32 cm tube with a 10 s hold on exhale.	Do 5 sets 10 s each

The pedagogical experiment used processed ski sticks, which were made into tubes of different sizes (72, 105, 132, 153 cm). One end of the tube has a diameter of 1,5 cm, is disinfected and inserted into the mouth cavity. The other end

of the tube has a diameter of 0,8 ml, and a balloon is attached to it. This training device can be made in a short period of time.

We present the scientifically methodological set of respiratory training devices, performing the set of health-improving respiratory exercises, which increase the performance of the respiratory and cardiovascular systems within the process of structuring respiration for the aerobic endurance (Table).

**Results and discussion.** The process of physical culture classes was conducted in compliance with established federal state standards and working programs of the new higher professional education in mandatory cycles and sections (specialties) of the third generation, which is necessary for students to learn while studying in the higher education institution.

The conducted studies revealed that students, who belong in the main and preparatory medical groups, performed the inhale through the nasal cavity; the exhale was performed with the air processed by the respiratory system through the training device. The following indicators were registered: the LC improved by  $335,47 \pm 97,78$  ml; the breath-holding test on inhale increased by  $14,56 \pm 7,78$  s; the breath-holding test on exhale increased by  $10,85 \pm 4,29$  s; the HR decreased by  $4,23 \pm 2,53$  beats/min; the thoracic mobility increased by  $3,47 \pm 1,27$  cm. The questionnaire revealed that performing the set of exercises on respiratory training devices allowed supporting substantially the positive state of the cardiorespiratory system and the total state of the organism of students before and after the COVID-19 pandemic [6-7].

Students of the special medical group performed physical exercises under the simplified curriculum. Health-improving respiratory exercises on simple respiratory training devices were used in physical culture classes. The conducted study showed that the LC increased by  $115,38 \pm 35,45$  ml; the breath-holding test on inhale increased by  $7,13 \pm 3,21$  s; the breath-holding test on exhale increased by  $3,21 \pm 1,53$  s; the HR decreased by  $2,79 \pm 1,35$  beats/min; the thoracic mobility increased by  $2,59 \pm 1,73$  cm. The questionnaire of this group showed that the respiration process and the total state of the organism improved positively.

Students, who engage in freestyle wrestling in the PNEPU sports group, showed following data: the LC increased by  $447,51 \pm 87,51$  ml; the breath-holding test on inhale increased by  $19,25 \pm 7,32$  s; the breath-holding test on exhale increased by  $11,33 \pm 4,35$  s; the HR decreased by  $5,36 \pm 3,13$  beats/min; the thoracic mobility increased by  $9,32 \pm 3,27$  cm. The questionnaire data from this group showed the positive improvement of the respiratory process and the total state of the organism [8-9].

Physiological mechanisms of respiration under the influence of systematic training classes allow expanding capabilities of the cardiorespiratory system, the

organism's adaptive readiness to deploy adaptive respiratory physiological processes. During multiple performance of the set of health-improving respiratory exercises using training devices (artificial environment conditions), the "respiratory dominant" forms in the cerebral cortex, which positively influences the state of the respiratory (external and internal) muscles, the cardiovascular and cardiorespiratory system.

**Conclusion.** Results of the pedagogical experiment showed the performance of the cardiorespiratory system, the efforts and strength development of the respiratory (external and internal) muscles increased by 9 mm of Mercury. The health improvement in students also got better. Use of respiratory training devices, on which the set of health-improving respiratory exercises, contributes to the development of the immune system in students, which is the main respiratory organ system able to prevent airways from COVID-10, dust particles, gas substances from automobiles, various viruses, bacteria and dangerous particulates, from fire, smoke and smog. The immune system makes respiratory organs stronger, always suspends and clears the entered air from a great number of different mixture, particulates and gases. Pulmonologists have concluded that 12-15% of the Perm' Region population have derivations in the state of the respiratory process.

The given training device can be in demand on sales market. For people, who suffer from diseases of the cardiovascular and respiratory systems, as well as for children and adolescents, the set of health improving respiratory exercises on training devices, located in medical institutions or in home conditions, was used. Children and adolescents, schoolchildren and students and the whole adult population of the country can use this training device to improve the respiratory system and the state of their health during physical culture classes and independent workout. The analysis and data gathering on more than 20 respiratory training devices (from the Federal Service of Intellectual Property – patents for invention) showed that they are too complicated and labor-intensive in their invention and creation and require large expenses of time and money. The developed respiratory training device is easy to use and make, is not demanding in terms of money, and the resources for can be obtained easily.

### **References**

1. Zelenin L.A. Scientifically theoretical and methodological non-traditional sanitary gymnastic respiratory technologies, influencing the state of health of students of the institute of culture / L.A. Zelenin // Penitentiary System and Society: Interaction Experience. Materials of the V International Scientific and Practical Conference, April 4-6, 2018. – Perm'. – 2018. – P. 401-404.

2. Zelenin L.A. The adjacent formation of the balance ability using the set of training devices when learning young canoe athletes: Doctor of Pedag. Sciences Diss.: 13.00.04 / L.A. Zelenin // Naberezhnye Chelny. – 2014. – P. 115-135.

3. Panachev V.D. Auto-training as a mean of forming stress tolerance in shooting sports // Collection of abstracts of scientific works of the Institute of Physical Education and Sports with international participation. – 22.04.20. – P.101-106.

4. Panachev V.D. Physiological basics of the aerobic performance in case of physical loads / V.D. Panachev, L.A. Zelenin, I.S. Skakovets // The RSCI Journal of the National Association of Scientists. – 2020. – Vol. 1. – № 60. – P. 21-23.

5. Ratov I.P. Concept of the prospects of the athletic training device development / I.P. Ratov // Theory and practice of physical culture. – 1990. – № 8. – P. 10-13.

6. Grimby G. Respiration as a limiting factor of working capacity / G. Grimby // Pneumonologie. – 1976. – Vol. 5. – P. 11-16.

7. Verges S. Effect of acute hypoxia on respiratory muscle fatigue in healthy human / S. Verges, D. Bachasson, B. Wuyam // Respiratory Research. – 2010. – № 11. – P. 109-112.

8. Kim M.J. Respiratory muscles training: implications for patient care / M.J. Kim // Heart and Lung. – 1984. – V. 13. – № 4. – P. 333-340

9. Debold E.P. Recent insights into the molecular basis of muscular fatigue / E. P. Debold // Med Sci Sports Exerc. – 2012. – Vol. 44. – № 8. – P.1440-1452.

### **Spisok literatury**

1. Zelenin L.A. Nauchno-teoreticheskie i metodologicheskie netraditsionnye ozdorovitel'nye gimnasticheskie dykhatel'nye tekhnologii, vliyayushchie na sostoyanie zdorov'ya studentov instituta kul'tury / L.A. Zelenin // Penitentsiarnaya sistema i obshchestvo: opyt vzaimodejstviya. Sbornik materialov V Mezhdunarodnyj nauchno-prakticheskoy konferentsii 4-6 aprelya 2018. – Perm'. – 2018. – S. 401-404.

2. Zelenin L.A. Sopryazhennoe formirovanie sposobnosti k ravnovesiyu posredstvom trenazhernogo kompleksa pri obuchenii yunyx sportsmenov-kanoistov: dis. ... d-ra ped. nauk : 13.00.04 / L.A. Zelenin // Naberezhnye Chelny. – 2014. – S. 115-135.

3. Panachev V.D. Autotrening kak sredstvo formirovaniya stressoustojchivosti v strelkovykh vidakh sporta / V.D. Panachev // Sb. tezisov nauchnykh rabot instituta fiz. vospitaniya i sporta s mezhdunar. uchastiem – 22.04.20. – S. 101-106.

4. Panachev V.D. Fiziologicheskie osnovy aerobnoj rabotosposobnosti pri fizicheskoj nagruzke / V.D. Panachev, L.A. Zelenin, I.S. Skakovets // Zhurnal RINTS NAU. – 2020. – T. 1. – № 60. – S. 21-23.

5. Ratov I.P. Kontsepsiya perspektiv razvitiya fizkul'turno-sportivnykh trenazhyorov / I.P. Ratov // Teoriya i praktika fizicheskoj kul'tury. – 1990. – № 8. – S. 10-13.

6. Grimby G. Respiration as a limiting factor of working capacity / G. Grimby // Pneumonologie. – 1976. – Vol. 5. – P. 11-16.

7. Verges S. Effect of acute hypoxia on respiratory muscle fatigue in healthy human / S. Verges, D. Bachasson, B. Wuyam // Respiratory Research. – 2010. – № 11. – P. 109-112.

8. Kim M.J. Respiratory muscles training: implications for patient care / M. J. Kim // Heart and Lung. – 1984. – Vol. 13. – № 4. – P. 333-340.

9. Debold E.P. Recent insights into the molecular basis of muscular fatigue / E.P. Debold // Med Sci Sports Exerc. – 2012. – Vol. 44. – № 8. – P. 1440-1452.

**Information about authors: Leonid Aleksandrovich Zelenin** – Doctor of Pedagogical Sciences, Associate Professor, Master of Sports, Correspondent Member of the Russian Academy of Natural History, Professor of the Department of Physical Culture of the Perm' National Research Polytechnic University, Associate Professor of the Department of Physical Training and Sports of the Perm' Military Institute of the National Guard Troops of the Russian Federation, Perm', e-mail: zelenindoz48@mail.ru; **Valerij Dmitrievich Panachev** – Doctor of Sociological Sciences, Professor, Master of Sports, Academician of the Russian Academy of Natural History, Head of the Department of Physical Culture of the Perm' National Research Polytechnic University, Associate Professor of the Physical Training and Sports of the Perm' Military Institute of the National Guard Troops of the Russian Federation, Perm', e-mail: panachev@pstu.ru.