MEDICAL SCIENCE

To Cite:
Polevoy G. Improving the functional capabilities of the body of children with respiratory diseases. *Medical Science* 2023; 27: e200ms3017.
doi: https://doi.org/10.54905/disssi/v27i134/e200ms3017

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Peer-Review History
Received: 29 March 2023
Reviewed & Revised: 31/March/2023 to 15/April/2023
Accepted: 19 April 2023
Published: 24 April 2023

Peer-review Method
External peer-review was done through double-blind method.

Medical Science
pISSN 2321–7359; eISSN 2321–7367

Improving the functional capabilities of the body of children with respiratory diseases

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ABSTRACT

Background: It is important to treat diseases of the respiratory system not only with medication, but also with the help of physical rehabilitation. *The purpose of the study:* Improving the functional efficiency of the body of primary school-age children with respiratory diseases. *Study design:* Pedagogical experiment. *Research methods:* Research was conducted from February 1 to March 31, 2023 on the basis of the Vyatka Kinesitherapy Center in the hall of therapeutic physical culture, Kirov (Russia). 48 school children aged 10-11 took part in the study. Students of experimental group additionally used physical exercises for the development of functional capabilities 3 times a week. Overall endurance was determined by a 6-minute run. Oxygen saturation of the body was determined by the tests "Stange test", "Genchi test", "Spirometry". *Results:* After the end of the study, the data in the control group improved by 0.8% in the "6-minute run" test, by 0.7% "Spirometry", by 3% "Stange test" and by 11.5% "Genchi test". In the Experimental group, the indicators were higher in the "6-minute run" test by 2%, "Genchi Test" by 12.8%, "Spirometry" by 2.5% and the indicators in the "Stange test" increased by 8.6% and showed a significant improvement ($P<0.05$). *Conclusion:* Children who have diseases of the pulmonary system should additionally engage in physical therapy 3 times a week, at least 1 hour, outside of school hours. The results of the study showed a significant effectiveness of the applied physical exercises for the development of functional abilities of students.

Keywords: Respiratory system, physical therapy, school children, health, pulmonary system.

1. INTRODUCTION

Respiratory diseases are one of the urgent problems of modern internal medicine, which is associated with their prevalence, significant impact on the quality of life and social functioning of a person (Shukla et al., 2020; Gould et al., 2023). Infections that are present in the lower respiratory tract have a serious prognosis, especially at the age of 7-10 years. In the last 10 years, numerous studies have shown that the structure of the respiratory microbiota

at an early age determines the increased risk of the frequency of subsequent respiratory infections, the severity of their course in older children. A deeper understanding of the complex interactions between bacteria, viruses and microorganisms can provide new opportunities for clinical therapy and prevention of respiratory diseases (Grundy, 1976).

The main causes of respiratory diseases:

1. Pathogenic organisms. These are pathogens of infectious processes; these are bacteria, such as mycoplasma, hemophilic bacillus, pneumococci and others.
2. External allergens. Plant pollen, animal allergens, fungal spores, food, household allergens and others.
3. Bad habits. Alcohol consumption and smoking, poor environmental conditions, other various diseases, hypothermia.

At the moment, many diseases of the pulmonary system are known, such as acute and chronic bronchitis, pneumonia, lung abscess, lung gangrene, bronchiectasia, chronic obstructive pulmonary disease, bronchial asthma, pulmonary emphysema, lung cancer, tuberculosis, pleurisy, pulmonary bleeding and spontaneous pneumothorax. The main causes of such diseases are bacterial or viral infection. Factors contributing to the appearance of this disease: Alcohol, smoking, hypothermia of the body, a focus of infection in the nasopharynx, violation of nasal breathing (Matić et al., 2020; Gould et al., 2023).

The negative impact of lung disease on the functional and physical development of primary school children is known, namely: There may be shortness of breath, lowering blood pressure, rapid pulse, impaired appetite, insomnia and tachycardia. There are cardiovascular diseases, kidney failure and the like. The child's working capacity decreases; there are pains in the bones, joints. Also, lung diseases lead to weakness, decreased performance, fatigue, increased sweating, prolonged fever, weight loss, enlarged lymph nodes, apathy, decreased mood (Shukla et al., 2020; Gould et al., 2023). Therapeutic physical culture (Mc-Ilwaine, 2007; Zhu et al., 2020) plays a great role in maintaining the optimal capabilities of the pulmonary system.

The main tasks of therapeutic physical culture:

1. Improvement of respiratory function.
2. Strengthening the respiratory muscles.
3. Increasing the excursion of the chest and diaphragm (the difference in the indicators of inhalation and exhalation in cm).
4. Promote stretching of pleural adhesions and cleansing of the respiratory tract from pathological secretions.

Basic means of therapeutic physical culture:

1. Physical exercises
2. Massage
3. Walking
4. Swimming
5. Wellness running
6. Training on simulators

In case of respiratory diseases, general restorative and special breathing exercises should be performed, which improve the activity of all organs and systems and activate the respiratory system. It should be emphasized that exercises of high and moderate intensity (Ceyhan and Kartin, 2022; Li et al., 2022) are demonstrated to activate the respiratory system.

When performing special exercises, the respiratory muscles are strengthened, the mobility of the diaphragm and chest increases and this helps to reduce congestion. Exercises should be selected so that they correspond to clinical data. Special breathing exercises are performed to improve ventilation in various parts of the lungs: For the tops of the lungs, deep breathing is used with the initial position of the hand on the belt, for the posterior sections – enhanced diaphragmatic breathing. The increase in ventilation of the lower parts is facilitated by exercises with lifting the head, spreading the arms to the sides and upwards, bending the trunk backwards in combination with diaphragmatic breathing. Special breathing exercises cause an increase in oxygen consumption and lung ventilation (Wong, 2000; Yun et al., 2021; Herawati et al., 2023). To date, there are several techniques for the development of the respiratory system. The most common are the volitional elimination of deep breathing by KP Buteyko and respiratory gymnastics by AN Strelnikova (Watson et al., 2021; Rochester and Goldberg, 2022).

After examining several techniques, we came to the conclusion that they are aimed at eliminating neurotic and other diseases, such as high blood pressure, elimination of bronchial spasm and some others. At the same time, we assume that these methods do not fully increase the functional capabilities of the children's body, but are more aimed at eliminating pathologies (Macêdo et al., 2016; Ubolnuar et al., 2018; Zaccaro et al., 2018). From the above, it is possible to identify a contradiction between the often-increasing number of respiratory diseases in children and shortcomings in modern methods of their treatment.

The purpose of the study

Improving the functional efficiency of the body of school children with diseases of the pulmonary system

Research objectives

1. To identify the causes of respiratory diseases and their impact on the functional and physical development of primary school children;
2. To analyze the means and methods of physical rehabilitation of primary school children with respiratory diseases;
3. To compile and test a set of exercises aimed at improving the functional capabilities of the body of primary school-age children with respiratory diseases.

Working hypothesis

It is assumed that the developed set of exercises will improve the functional efficiency of the body of primary school-age children with lung diseases.

2. MATERIALS AND METHODS

Study design

The main method of research was a pedagogical experiment.

Study participants

Our study involved boys and girls aged 10-11 years (48 children) who studied in ordinary schools in the city of Kirov. Children who took part in the pedagogical experiment were admitted to classes by a doctor. The students had respiratory diseases. Parents of school children signed an informed consent to the child's participation in the pedagogical research.

Inclusion criteria

School children aged 10-11 with disorders of the pulmonary system (respiratory diseases).

Exclusion criteria

Healthy children and those who have severe health problems (obesity of the 3rd degree, hypertension and joint diseases) are not allowed by the doctor to take tests and functional tests.

All procedures were carried out in accordance with the ethical standards of the Helsinki Declaration of 1964. The study was approved by the special committee on the ethics of scientific research. Vyatka State University. Minutes of the meeting No. 1 dated January 17, 2022.

Research procedure

The pedagogical research was conducted from February 1 to March 31, 2023 on the basis of the Vyatka Kinesitherapy Center, Kirov (Russia), in the hall of therapeutic physical culture. A total of 26 classes were conducted using the experimental method. The children who were assigned to the control group passed the control standards and did not perform special physical exercises.

The children who were assigned to the experimental group additionally came to the kinesitherapy center after school and performed special complexes on the respiratory system. The duration of the physical therapy class was 1 hour. Classes were held 3 times a week (Monday, Wednesday, Friday 15:00-16:00). Students had to perform each exercise 6-8 times.

Sample exercises without subjects

Exercises without subjects

Starting position (S.P.) the leg stand is shoulder-width apart; the arms are lowered.

1. Spread your arms apart (palms up), stretch and take a deep breath, then exhale.
2. Inhale through the nose, tilt to the right and exhale through the mouth. Then to the left.
3. Hands up through the sides and inhale through the nose then exhale through the mouth – hands down.
4. Tilt to the right, hands slide along the trunk on exhalation, then on inhalation exit to the S.P. Also, to the left side.
5. S.P. + Brushes to the shoulders. When inhaling, perform a torso turn to the right and spread your arms to the sides, then to the left.

6. On exhalation, tilt forward, arms to the sides, then inhale and S.P.
7. Maximum inhalation through the nose, then intermittent exhalations through the mouth.
8. Inhale through your nose, hold your breath for 8 seconds and then slowly exhale through your mouth.
9. Perform the maximum exhalation and then the maximum inhale and hold your breath for 5 seconds.
10. On the inhale, push out your stomach, on the exhale – pull in your stomach.
11. S.P. + sitting on a chair. Turn the torso to the left + inhale, return to the S.P. and exhale. Then in the other direction.
12. S.P. + lying on your back. Slowly lift your legs up to an upright position. Rest your elbows and palms on the floor, support your back. The back of the head and neck are pressed to the floor.

Sample exercises with subjects

1. On the inhale stick up, on the exhale squat – stick on your knees.
2. S.P. + ball in front of the chest. When inhaling, turn to the left (the ball is forward), not exhaling – S.P. Then to the right.
3. S.P. + a stick on the shoulder blades. Bend (shoulders back) and inhale. Tilt forward – exhale.
4. S.P. + ball on the floor. Inhale – hands up, exhale – bend down and take the ball. Inhale – straighten up with the ball hands up, exhale to put the ball on the floor.
5. S.P. + stick at the bottom. Inhale – stick up (left foot back, on the toe), exhale – S.P., then with the right foot.
6. S.P. + stick at the bottom. Inhale – lunge with the right foot forward, stick up. Exhale – S.P., then with the left foot.
7. S.P. + stick at the bottom. Inhale – hands up, exhale – raise the knee to the stomach with a stick. Exhale – S.P. Then with the other knee.
8. S.P. + stick and ball at the bottom. Inhale – hold your breath for 6-8 seconds, then slowly exhale and hold your breath again for 6-8 seconds.
9. S.P. + sitting, the ball on your knees. Inhale – lift the ball up. Exhale – tilt forward.
10. S.P. + sitting, the ball is at the top. Inhale – tilt to the right. Exhale – S.P., then to the left.
11. S.P. + lying on your back, stick at the top. Exhale – take the thrust position (stick up), Inhale – S.P.
12. S.P. + lying on your back, bend your leg at the knee and grab it with a stick and press it to your chest for 12-15 seconds, then lower your leg. After that, perform the exercise with the other leg.

All school children who were admitted by the doctor before the pedagogical experiment passed control standards and functional tests.

1. Determination of general endurance (Cooper's 6-minute test) (Lyakh, 2020). The result is the distance that schoolchildren run in 6 minutes. School standards for 4th grade students: Grade "5" – 1245 m., grade "4" – 1120 m., grade "3" – 985 m.
2. Determination of oxygen saturation of the body (Tomaszewski et al., 2023):

a. On inhalation (Stange test). The breath lingers on the inhale. With the help of a stopwatch, the time of holding your breath is calculated. You need to perform the test sitting down. Result: Arithmetic mean of 3 attempts. Approximate indicators of the Stange test for children of grades 4 – 40-51 sec.

b. On exhalation (Genchi test). The requirements and evaluation of the result are the same as in the test Rod. Approximate indicators for children of grades 4 – 21-23 sec.

3. Measurement of the vital capacity of the lungs (Spirometry). It is necessary to take a deep breath and a maximum, but gradual exhalation (within 5-7 seconds) through the mouthpiece of the spirometer through the mouth. The study is carried out 3 times with an interval of 50-60 seconds. The result is the maximum value of three attempts. Approximate indicators of spirometry for children from grades 4 – 1545 ml.

Statistical processing of research data

To process the results, the student's t-criterion method of mathematical statistics was used. At $P<0.05$, the difference was considered significant. As a result of using this method, data is obtained that confirm or refute the hypothesis of the study.

3. RESULTS

To evaluate the effectiveness of the experimental technique with school children aged 10-11 years with respiratory diseases, various functional tests and tests were used, which were conducted before and after the experiment. The obtained results were processed using mathematical statistics of the student's t-test and presented (Table 1).

Table 1 Comparison of the indicators of children from the experimental and control groups before the start of the pedagogical research

Tests	Experimental group (n=24)	Control group (n=24)	T	P
6-minute run (meters)	725,25±22,35	728,5±20,45	0.05	P>0.05
Stange test (sec.)	33,1±0,61	31,25±0,89	0.81	P>0.05
Genchi test (sec.)	12,5±0,55	11,75±1,15	0.3	P>0.05
Spirometry (ml.)	1242,75±26,08	1249,5±27,05	0.08	P>0.05

Table 1 shows that the results obtained at the beginning of the study have no significant differences (the groups according to the studied indicators are homogeneous). If we compare the data obtained with the indicators of healthy children, we can state that the results obtained for all indicators are an order of magnitude lower than the average values of healthy children from the 4th grade.

In order to evaluate the effectiveness of the developed methodology, after the pedagogical experiment, control tests, functional tests and mathematical statistics of data comparison according to the student's t-criterion were conducted. The data from the control are presented (Table 2).

Table 2 Comparison of data of children from the control group from the beginning to the end of the research (n=24)

Tests	Before starting the study	After the end of the experiment	%	P
6-minute run (meters)	728,5	734	0.8	P>0.05
Stange test (sec.)	31,25	32,2	3	P>0.05
Genchi test (sec.)	11,75	13,1	11.5	P>0.05
Spirometry (ml.)	1249,5	1258	0.7	P>0.05

Table 2 shows that students from the control group during the study period were able to increase the indicators in all tests (samples), but the improvements were not significant from 0.7% in the Spirometry test to 11.5% in the Genchi test. School children from the experimental group also took tests at the beginning and at the end of the pedagogical experiment; the data are presented (Table 3).

Table 3 Comparison of data of school children from the experimental group from the beginning to the end of the research (n=24)

Tests	Before starting the study	After the end of the experiment	%	P
6-minute run (meters)	725,25	740	2	P>0.05
Stange test (sec.)	33,1	35,9	8.6	P<0.05
Genchi test (sec.)	12,5	14,1	12.8	P>0.05
Spirometry (ml.)	1242,75	1274	2.5	P>0.05

Table 3 shows that the performance of students from the experimental group improved on all tests. The positive increase ranged from 2% in the "6-minute run" test to 12.8% in the "Genchi test". In the "Stange test", the data from the beginning to the end of the research were significantly higher (P<0.05). Since there were no significant differences between the control and experimental groups in all tests (samples) before the start of the study, we compared the final indicators after the experiment between these groups. The data is given (Table 4).

Table 4 Comparison of children's indicators between the control and experimental groups after the pedagogical experiment

Tests	Experimental group (n=24)	Control group (n=24)	T	P
6-minute run (meters)	740	734	1.75	P>0.05
Stange test (sec.)	35,9	32,2	3.14	P>0.05
Genchi test (sec.)	14,1	13,1	0.63	P>0.05
Spirometry (ml.)	1274	1258	3.4	P<0.05

Table 4 shows that the indicators of students from the experimental group are higher than those of children from the control group. At the same time, the indicators in the "Spirometry" test turned out to be significantly higher at the end of the experiment in children of the experimental group (P<0.05).

The final tests and functional tests at the end of the pedagogical experiment showed that the indicators of children of the experimental group were higher than those of children in the control group. To see the changes during the period of pedagogical research in both groups, we presented the data obtained in the form of a diagram for all tests (Figure 1).

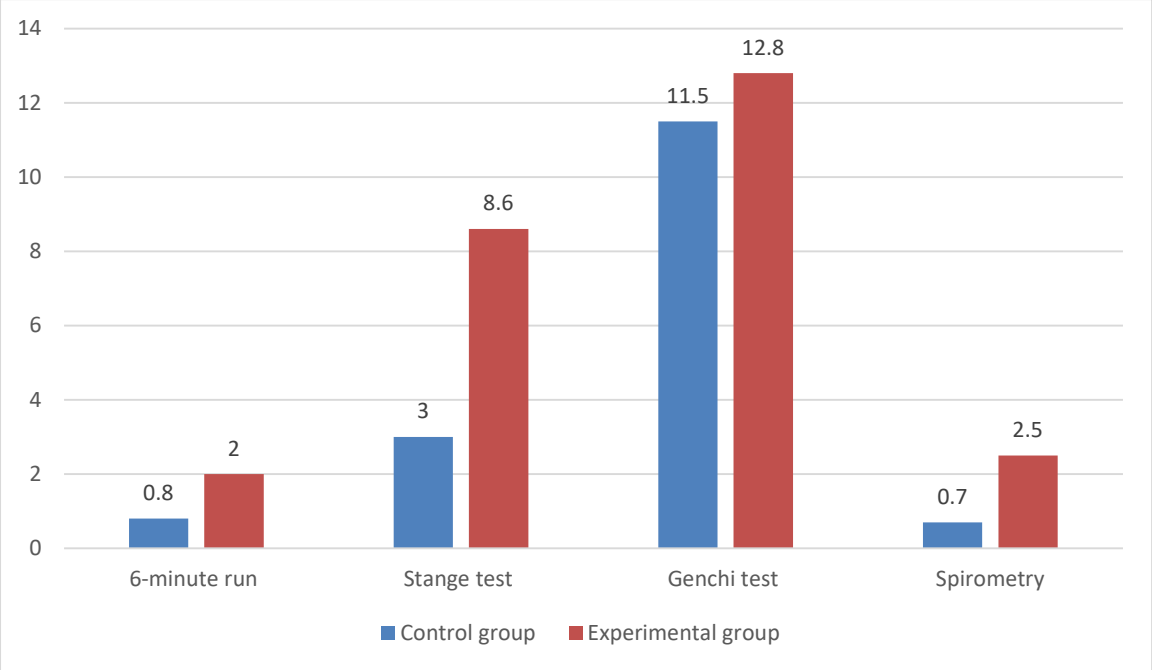

Figure 1 The increase in children's data from the beginning to the end of the research for all indicators

Figure 1 shows that the indicators of children aged 10-11 from the experimental group during the period of the pedagogical study became higher on all tests. From the above, it can be concluded that the set of exercises, which is aimed at improving the functionality of primary school children with respiratory diseases, has confirmed its effectiveness.

4. DISCUSSION

If we turn to the scientific literature, we will see a large number of studies that are devoted to human health, the normal process of growth and development of the body (Fsadni et al., 2018; Wright et al., 2018). The literature review showed the importance of studying the problem of diseases of the pulmonary system (Shukla et al., 2020; Gould et al., 2023). Special attention should be paid to children who study at school. To date, there are several breathing techniques (Ubolnuar et al., 2019; Watson et al., 2021; Rochester and Goldberg, 2022), but they are aimed at eliminating various diseases (high blood pressure, neurotic problems). A detailed analysis of the methods showed that they have insufficient effect on the functional capabilities of the body of school children.

Therapeutic physical culture is of great importance for the pulmonary system and for health in general (it increases respiratory functions, strengthens respiratory muscles and the work of the diaphragm). There are several means of physical therapy, such as massage, active motor activity (walking, running), swimming, training on simulators (Zhu et al., 2020; Ceyhan and Kartin, 2022; Li et al., 2022). However, in our study, the problem of the respiratory system is touched upon. This is important because every year poor ecology and a number of other factors increase the number of people with problems of the pulmonary system. It is known that various diseases of the respiratory system negatively affect the functional and physical development of children of primary school age, namely: There may be shortness of breath, lowering blood pressure, rapid pulse, impaired appetite, insomnia and tachycardia. Against the background of diseases, cardiovascular diseases, kidney failure, etc. may occur. The child's working capacity decreases; there are pains in the bones, joints. Also, diseases lead to weakness, decreased performance, fatigue, increased sweating, prolonged fever, weight loss, enlarged lymph nodes, apathy, decreased mood and many other various disorders and diseases (Matić et al., 2020; Shukla et al., 2020).

We have developed a set of physical exercises aimed at improving the functional systems of the body of school children with respiratory diseases. As a result of the use of a set of exercises, improvements in average group indicators are visible in school children aged 10-11 years: In students from the experimental group in the "6-minute run" test, the indicators improved by 2% ($P>0.05$), while in the control group, children who did not perform additional exercises for the pulmonary system, the indicators

also improved by only 0.8% (P>0.05). If we compare the group indicators with the standards of the school physical education program for children from the 4th grade (Lyakh, 2020), then we will see the following. Children from both subgroups lag behind their peers at the beginning and at the end of the study, since even for a grade of "3" it is necessary to run 985 m, which is 200 meters more than in both subgroups.

Changes also occurred in functional tests: The "Stange test" in the experimental group improved by 8.6% (P<0.05) and in the control group by 3% (P>0.05). If we compare the group indicators with healthy schoolchildren, then we will see that normally the "Stange test" should be 40-51 seconds. This is 5 and 8 seconds longer than in the experimental and control groups, respectively. The "Genchi test" in the experimental group improved by 12.8% (P>0.05) and in the control group by 11.5% (P>0.05). When comparing the students from our study and the approximate standards for grades 4, we can see a difference of almost 2 times in the advantage of healthy children.

The "Spirometry" indicators in the experimental group were 2.5% higher (P>0.05) and in the control group by 0.7% (P>0.05). As for the comparison of schoolchildren with the standards of grades 4, their indicators of 1258 ml (control group) and 1274 ml (experimental group) also lag behind the indicators of the norm of 1545 ml. However, despite the fact that children with diseases of the pulmonary system could not achieve the indicators of standards and functional tests of the level of healthy children, we see that the set of exercises had a positive effect on the functional systems of school children aged 10-11 years.

Thus, this technique has shown its effectiveness and can be used in educational and medical institutions to improve the functional systems of the body in children of primary school age with respiratory diseases. It is important to follow some practical recommendations when working with children who have respiratory diseases. During classes, you should gradually increase the load on the body by increasing the dosage of the exercises performed. If signs of external fatigue appear, the dosage of physical exercises should be reduced. You should give homework for independent performance of breathing exercises.

5. CONCLUSION

If children aged 10-11 years who have diseases of the pulmonary system will additionally perform physical exercises for breathing (therapeutic physical culture) 3 times a week for 1 hour, then the indicators of the functional capabilities of the body of schoolchildren will improve.

Acknowledgment

The authors would like to thank all participation and corporate in our study.

Authors' Contribution

Georgiy Polevoy: Conception, Study design, Data collection, Design writing, Data analysis, Manuscript Preparation

Ethical Approval

This pedagogical experiment was approved by the Committee on Ethics of Scientific Research of Vyatka State University. Protocol-document of the meeting of the Ethics Committee of the University dated January 17, 2022 number 1.

Funding

This study has not received any external funding.

Conflict of interest

The authors declare that there is no conflict of interests.

Data and materials availability

All data sets collected during this study are available upon reasonable request from the corresponding author.

REFERENCES AND NOTES

1. Ceyhan Y, Kartin PT. The effects of breathing exercises and inhaler training in patients with COPD on the severity of dyspnea and life quality: A randomized controlled trial. Trials 2022; 23(1):707. doi: 10.1186/s13063-022-06603-3
2. Fsadni P, Bezzina F, Fsadni C, Montefort S. Impact of School Air Quality on Children's Respiratory Health. Indian J Occup Environ Med 2018; 22(3):156-162. doi: 10.4103/ijoem.IJOEM_95_18

3. Gould GS, Hurst JR, Trofor A. Recognising the importance of chronic lung disease: A consensus statement from the Global Alliance for Chronic Diseases (Lung Diseases group). Respir Res 2023; 24:15. doi: 10.1186/s12931-022-02297-y
4. Grundy PF. A cohort study of mortality in relation to lung function. Proc R Soc Med 1976; 69(12):935-6.
5. Herawati I, Mat-Ludin AF, MM, Ishak I, Farah NMF. Breathing exercise for hypertensive patients: A scoping review. Front Physiol 2023; 14:1048338. doi: 10.3389/fphys .2023.1048338
6. Li Y, Ji Z, Wang Y, Li X, Xie Y. Breathing Exercises in the Treatment of COPD: An Overview of Systematic Reviews. Int J Chron Obstruct Pulmon Dis 2022; 17:3075-3085. doi: 10.2147/COPD.S385855
7. Lyakh VI. Working program on physical culture at school for children of grades 1-4. Teacher: Moscow, Russia 2020; 266.
8. Macêdo TM, Freitas DA, Chaves GS, Holloway EA, Mendonça KM. Breathing exercises for children with asthma. Cochrane Database Syst Rev 2016; 4(4):CD011017. doi: 10.1002/14651858.CD011017
9. Matić Z, Platiša MM, Kalauzi A, Bojić T. Slow 0.1 Hz Breathing and Body Posture Induced Perturbations of RRI and Respiratory Signal Complexity and Cardiorespiratory Coupling. Front Physiol 2020; 11:24. doi: 10.3389/fphys.2020.00024
10. Mc-Ilwaine M. Chest physical therapy, breathing techniques and exercise in children with CF. Paediatr Respir Rev 2007; 8(1):8-16. doi: 10.1016/j.prrv.2007.02.013
11. Rochester DF, Goldberg SK. Techniques of Respiratory Physical Therapy. Am Rev Respir Dis 2022; 122(5 Pt 2):133-46. doi: 10.1164/arrd.1980.122.5P2.133
12. Shukla SD, Swaroop-Vanka K, Chavelier A, Shastri MD, Tambuwala MM, Bakshi HA, Pabreja K, Mahmood MQ, O'Toole RF. Chronic respiratory diseases: An introduction and need for novel drug delivery approaches. Targeting Chronic Inflammatory Lung Diseases Using Advanced Drug Delivery Systems 2020; 1-31. doi: 10.1016/B978-0-12-820658-4.00001-7
13. Tomaszewski EL, Atkinson MJ, Janson C. Chronic Airways Assessment Test: Psychometric properties in patients with asthma and/or COPD. Respir Res 2023; 24:106. doi: 10.1186/s12931-023-02394-6
14. Ubolnuar N, Tantisuwat A, Thaveeratitham P, Lertmaharit S, Kruapanich C, Mathiyakom W. Effects of Breathing Exercises in Patients with Chronic Obstructive Pulmonary Disease: Systematic Review and Meta-Analysis. Ann Rehabil Med 2019; 43(4):509-523. doi: 10.5535/arm.2019.43.4.509
15. Watson M, Ionescu MF, Sylvester K, Fuld J. Minute ventilation/carbon dioxide production in patients with dysfunctional breathing. Eur Respir Rev 2021; 30(160):200182. doi: 10.1183/16000617.0182-2020
16. Wong WP. Physical Therapy for a Patient in Acute Respiratory Failure. Phys Ther 2000; 80(7):662-670. doi: 10.1093/ptj/80.7.662
17. Wright CY, Nkosi V, Wichmann J. Respiratory Health Symptoms among Schoolchildren in Relation to Possible Food-Related Risk and Protective Factors. Int J Environ Res Public Health 2018; 15(3):502. doi: 10.3390/ijerph15030502
18. Yun R, Bai Y, Lu Y, Wu X, Lee SD. How Breathing Exercises Influence on Respiratory Muscles and Quality of Life among Patients with COPD? A Systematic Review and Meta-Analysis. Can Respir J 2021; 29:1904231. doi: 10.1155/2021/1904231
19. Zaccaro A, Piarulli A, Laurino M, Garbella E, Menicucci D, Neri B, Gemignani A. How Breath-Control Can Change Your Life: A Systematic Review on Psycho-Physiological Correlates of Slow Breathing. Front Hum Neurosci 2018; 12:353. doi: 10.3389/fnhum.2018.00353
20. Zhu Y, Wang Z, Zhou Y, Onoda K, Maruyama H, Hu C, Liu Z. Summary of respiratory rehabilitation and physical therapy guidelines for patients with COVID-19 based on recommendations of World Confederation for Physical Therapy and National Association of Physical Therapy. J Phys Ther Sci 2020; 32(8):545-549. doi: 10.1589/jpts.32.545