

## Physiological Beneficial Changes in the Respiratory System in Adolescents with Chronic Obstructive Bronchitis as a Result of the use of a set of Yogic Exercises

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In the modern world, the incidence of chronic obstructive bronchitis in adolescents remains quite high. Due to the high incidence of chronic obstructive bronchitis in adolescents, there remains an urgent need for medical science to improve the rehabilitation of this contingent of patients. The aim of the work is to assess the rehabilitation possibilities of yoga exercises in adolescents suffering from chronic obstructive bronchitis. The study was carried out on 46 adolescents aged 14-15 years old, suffering from uncomplicated chronic obstructive bronchitis for a long time in a state of unstable remission. The control group included 22 clinically healthy adolescents of the same age. For those surveyed with chronic bronchitis, there was a decrease in lung volumes and the size of the lumen of the bronchi of any diameter. This naturally reduced the functional capabilities of the respiratory system in adolescents. Regular yogic exercises provided in adolescents with bronchitis a pronounced positive dynamics of their well-being and adaptive capabilities of the respiratory system. Systematic yoga exercises optimized the functional capabilities of the entire respiratory system in adolescents with chronic obstructive bronchitis and significantly increased their resistance to hypoxia.

**Keywords:** Adolescents, Chronic obstructive bronchitis, yogic exercises.

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Throughout ontogenesis, each organism is constantly influenced by the environment, often disrupting its viability<sup>1,2</sup>. Coming changes in the body under the influence of environmental factors cause a number of adaptive processes aimed at adapting to the conditions of existence<sup>3,4</sup>. However, excessive changes in the body can sometimes lead to various types of pathology<sup>5,6</sup>.

Quite often, pathological processes in the human body affect the heart, blood vessels, the blood system and the broncho-pulmonary system. The appearance of disturbances in each of these systems greatly weakens the overall vitality of the organism as a whole<sup>7</sup>. At the same time, lung diseases are now widespread among children and especially among adolescents. Very

often in adolescence, chronic obstructive bronchitis began to be registered, with a tendency to frequent recurrence<sup>8</sup>.

In conditions of chronic obstructive bronchitis, the morpho-functional state of the bronchial walls always changes. This pathology is manifested by a cough with sputum, often of a serous-purulent nature. It is exacerbated after hypothermia or after inhalation of air with industrial impurities<sup>9</sup>.

The frequent occurrence of chronic obstructive bronchitis among young people and the serious danger of its progression with the appearance of its complications creates an urgent need to improve approaches to the rehabilitation of this category of adolescent patients<sup>10</sup>.

The drugs available in the arsenal of medicine for the routine therapy of chronic obstructive bronchitis cannot be used for a long time<sup>11</sup>. In this regard, modern researchers consider it necessary to continue to develop various non-drug healing methods for such patients. Recognized as a very promising treatment for chronic obstructive bronchitis in yogic exercises<sup>12</sup>.

**Purpose:** to assess the rehabilitation capabilities of yogic exercises in adolescents suffering from chronic obstructive bronchitis.

## MATERIAL AND METHODS

This observation was fully approved by the local ethics committee of the Russian State Social University on March 15, 2017 (Protocol No. 3). After the consent of their parents, 46 adolescents of 14-15 years old with a diagnosis of chronic obstructive bronchitis for at least 5 years were taken under observation. No adolescent showed signs of respiratory distress. When taken into the study, chronic obstructive bronchitis in all adolescents was in the stage of unstable remission. The control group consisted of 22 adolescents of the same age, clinically completely healthy and without any complaints during the last year.

The adolescents with chronic obstructive bronchitis taken into the study underwent rehabilitation measures for 4 months. The methodology tested was based on yoga exercises that optimize the functioning of the bronchopulmonary system and the condition of

the chest. The wellness activities included the daily practice of a series of yogic exercises.

1. Yogic exercise "Cobra". Starting position - lie down on your stomach, connect your feet, put your hands under your shoulders. The palms are fully pressed to the floor, shoulder-width apart or slightly wider. Legs are straightened, joined together, socks should be extended. When inhaling, you need to create support on your hands, slowly raise your head and upper body, tilting them back. Press the lower body and legs to the floor. Achieve maximum breath holding. After exhaling gradually, go to the starting position. The exercise is done 8-10 times. With its help, the muscles of the trunk are trained, which realize the act of breathing and activate the adrenal glands.

2. Yoga exercise "Locust". The starting position is lying on your stomach with your chin touching the floor. Arms should be placed along the body, hands should be squeezed, socks should be extended. You should take a deep breath, while lifting your right leg as high as possible. At the moment of holding the breath during inhalation, keep the leg raised to the maximum height, then lower it to its original position. Perform a similar movement with the second leg. Then, leaning on your fists, raise your chest up from the floor level and bend strongly. You need to tilt your head back a little and look up, while you need to hold your breath while inhaling. Repeat the exercise 8-10 times. With its help, the cardiovascular system, all the muscles of the back and the anterior abdominal wall are toned, and the mobility of the diaphragm is improved.

3. Yogic exercise "Bow". The starting position is lying on your stomach. It is necessary to raise the legs bent at the knees, clasping the ankles with your hands. You should take a deep breath and stretch your legs up, while actively arching your back. Remain in this position during the holding of the breathing process. During exhalation, slowly lower your legs. First, spread your knees, then raise your legs high and connect them together. The exercise should be done 10-12 times. This exercise massages the heart and all organs of the chest cavity. At the same time, the lungs increase in volume, their work improves, which has a positive effect on the treatment of chronic obstructive bronchitis.

4. Yogic exercise "Folding knife". The initial position of the body is lying on your back with outstretched legs. Take a deep breath and, during exhalation, ensure the rise of one bent leg. With two upper limbs, press the knee strongly against the front surface of the abdomen, holding the breathing process. Having placed your hands on the sides of the body, you need to straighten the leg and, during exhalation, slowly lower it to the state of exodus. Perform such a movement with the second leg, and then carry out the movement with both lower limbs at once. The exercise must be repeated 8-10 times. It increases the tone of the abdominal muscles, which reduces its volume and increases the degree of mobility of the diaphragm.

5. Yoga exercise "Birch". The initial position is lying on your back. The arms are parallel to the body. When exhaling, the legs should be bent at the knees and brought to the abdomen. Then you need to rest your hands on your back, straightening your torso up. You should press your chin to your chest, and lower your shoulders and neck to the floor. The exercise is performed 8-10 times. This exercise optimizes the vascular tone in the brain, activating the central nervous system.

6. Yogic exercise "Cleansing breath". Start from a standing position. At the end of the maximum exhalation, a new breath is taken through the nose. Then, exhalation is performed through the mouth with the lips tightly pressed to the teeth, in conditions of strong tension of the abdominal muscles and the muscles of the intercostal space. Exercises are done 6-8 times.

7. Yogic exercise "Forging bellows". The initial position of the body is sitting in the "lotus" position. A maximum exhalation is carried out, then a quick inhalation and again a quick exhalation through the nose. This is done 10 times. Then, after exhaling, the breath is held for 7-10 seconds. The next breath is carried out slowly - for 10-15 seconds. Do the same with the head thrown back, and then with the chin down on the chest. Strive to bring the number of breaths during one series to 25-30. The exercise is repeated 5 times. This exercise helps to increase the volume, cleanse and regenerate the lungs.

8. Yogic exercise "Noisy breathing". The starting position is in the lotus position. Having carried out a full exhalation, they make a full breath for 4 counts, then in the course of one

count they make a powerful exhalation. First, a shallow breath is taken with an inactive exhalation. Gradually inhale deeply, and exhale more active and strong. The exercise should be repeated 5 times. This exercise strengthens the chest muscles and increases lung capacity.

9. Yoga exercise "Rhythmic breathing on the go." At the end of the full act of exhalation, the act of full inhalation is performed in rhythm with the steps being taken. At the expense of 4, the act of inhalation is done, and the exhalation process is 2 times longer. At the beginning, breathing is carried out without tension for 3 minutes. Its duration should be gradually increased to 15-30 minutes. Inhalation should be gradually increased to 8 steps, exhalation should be gradually increased to 16 steps. The exercise is repeated 5 times. This exercise helps to increase lung capacity, which is very important in the treatment of lung diseases.

10. Yoga exercise "Vacuum breathing". The initial position of the body is standing. You should bend forward, carry out a full act of exhalation, then straighten up, straighten your chest forward, as when inhaling. In this case, the chest is expanded and the stomach is drawn inward. The number of abdominal movements during one exhalation should be gradually increased from 3 to 30. This exercise is repeated 5 times. This exercise expands the chest, which helps to increase the volume of the lungs and improve gas exchange in them.

The spirometer SMP-21/01-R-D manufactured by Monitor (Russia) was used to carry out the study. A spirogram was recorded on this device, with the help of which the value of the minute volume of respiration, the volume of the vital capacity of the lungs, the value of the reserve volume of inspiration, the maximum ventilation of the lungs, the reserve volume of the expiratory act, the volume of the forced vital capacity of the lungs, the value of forced expiration, realized in 1 second, the speed peak volumetric, maximum volumetric speed in conditions of 25%, 50% and 75% of the volume level of the forced vital capacity of the lungs.

In the course of the study, the results of the Stange functional test were recorded in the subjects, taking into account the longest time of holding the act of breathing under conditions of inspiration. It was always done while sitting after 5 minutes of

rest. A full inhalation and exhalation were made, after inhalation (80-90% of the maximum) with a holding of the breath for the maximum possible time<sup>13</sup>.

All the subjects underwent a functional Genchi test, recording the maximum time of holding the breath at the moment of exhalation. After 5 minutes of rest in a sitting position, the subjects made a full exhalation and inhalation and exhalation again with holding the breath<sup>13</sup>.

The functional state of the cardiorespiratory system was assessed by the value of the Skibinsky index, which made it possible to assess the work of the external respiration system and its resistance to the development of hypoxia. The Skibinsky index was calculated using the following calculation scheme: vital capacity of the lungs / 100 × Stange's test, s / heart rate. If the indicator was less than 5, it was considered very bad; at 5-10 - it was considered unsatisfactory; at 10-30 - it was considered satisfactory; at 30-60 - it was considered good; 60 and more - considered that the condition of the indicator is very good.

The degree of chest excursion was assessed using a measuring tape, which was applied on the back at the level of the scapula angles, and on the chest above the mammary glands, calculating the difference between the largest expiration and the largest inhalation<sup>13</sup>.

The digital results of the study were processed using the Microsoft Excel statistical software package. The calculation of the arithmetic mean (M) and the error of the arithmetic mean (m) was carried out. To determine the statistical differences between the indicators, the Student's t test was used.

### **Research results and their discussion**

In sick adolescents in the initial state, a clear violation of the parameters of external respiration was found (Table 1).

The value of the vital capacity of the lungs in the sick adolescents was 38.9% lower than in the control group. The index of forced vital capacity of the lungs in patients was also lower than the control value by 41.2%. In terms of forced expiration within 1 second, healthy adolescents exceeded the level of adolescents with chronic obstructive bronchitis by 53.3%.

At the time of inclusion in the observation group in sick adolescents, the values of the results

of hypoxic tests and the degree of chest mobility were significantly lower than in the control group. The value in the outcome of the Skibinsky index in adolescents with chronic obstructive bronchitis was 2.0 times less than in the control.

The level of minute respiratory volume in adolescents with chronic obstructive bronchitis exceeded the control level by 22.5%. This was accompanied by a decrease in the level of maximum ventilation of the lungs by 23.3% in patients. When taken under observation in adolescents suffering from chronic obstructive bronchitis, the value of the peak velocity was lower than the control by 65.4%. At the same time, their average value of the maximum volumetric velocity in conditions of 25% of the level of forced vital capacity of the lungs was reduced by 41.9%. At the same time, in patients, the maximum volumetric velocity in conditions of 50% and 75% of the value of the forced vital capacity was inferior to the control by 39.1% and 26.7%, respectively.

After 4 months of regular yoga exercises in adolescents, suffering from chronic obstructive bronchitis, there was an increase in the vital capacity of the lungs to control values (by 38.9%). The volume of the forced vital capacity of the lungs in these adolescents by the end of the observation reached the control level, having increased by 35.3%. At the end of the study, the forced expiratory volume within 1 second in the group of patients corresponded to the control level due to its increase by 46.7%.

At the same time, in sick adolescents performing yoga exercises, the results of hypoxic tests and the degree of chest mobility increased significantly, reaching the level of the control group. The value of the average value of the Skibinsky index in adolescents with chronic obstructive bronchitis increased and at the end of the study reached the value characteristic of control.

Against the background of yoga exercises in adolescents with chronic obstructive bronchitis, the volume of minute respiration normalized due to its decrease by 20.2%. This was accompanied by an increase (by 20.3%) to the level of control of the indicator of maximum ventilation of the lungs.

Regular yogic exercise has resulted in a 57.7% increase in peak volumetric velocity in adolescents with chronic obstructive bronchitis.

They developed a 38.7% increase in maximum volumetric velocity under conditions of 25% of the forced vital capacity of the lungs. In adolescent patients, at the end of the study, the maximum volumetric velocity in conditions of 50% and 75% of the value of the forced vital capacity increased by 26.1% and 20.0%, respectively.

Despite the active development of medicine in the field of prevention, in modern adolescents, chronic obstructive bronchitis remains a very common pathology. It often occurs at an early age and then gradually progresses<sup>14</sup>.

The appearance of pathology in the respiratory system always negatively affects the state of the respiratory system. Already in adolescence, in the case of the development of chronic obstructive bronchitis with bronchial obstruction, there is a significant deterioration in the functioning of the respiratory system<sup>15</sup>.

The examined patients are characterized by a clear decrease in the level of indicators of vital capacity of the lungs. Their values of the forced vital capacity of the lungs were much lower than those in the control. The increase in the phenomena of bronchial obstruction in patients caused a decrease in the magnitude of forced expiration in them for a second. In addition, adolescents with chronic obstructive bronchitis initially had a decrease in the level of maximum ventilation. The obtained indicators can be considered as evidence

of the functional weakness of the respiratory system in the examined adolescents with chronic obstructive bronchitis with symptoms of bronchial obstruction.

Registration of the value of the minute volume of respiration revealed its excessive increase in those who had chronic obstructive bronchitis. This was accompanied in them by a low peak volumetric velocity, which indicated a weakness in their functional characteristics of the respiratory muscles and a small lumen of the airways<sup>16</sup>. The value of the maximum volumetric velocity found initially low in sick adolescents under conditions of 25% of the total value of the forced vital capacity of the lungs indicated a decrease in the diameter of their large bronchi<sup>9</sup>. The low in outcome in adolescents with chronic obstructive bronchitis, the average value of the parameter of the maximum volumetric velocity in conditions of 50% and 75% of the total value of the forced vital capacity of the lungs indicated low patency in adolescents of medium and small diameter bronchi.

The low level of indicators of hypoxic tests and a small excursion of the chest in the outcome in adolescents with chronic obstructive bronchitis indicated a pronounced resistance of the respiratory center in them to hypoxia and a weak ability to adapt the respiratory system. The initially low value of the Skibinsky index indicates

**Table 1.** Functional characteristics of external respiration in the examined

Respiration rates M±m	Adolescents with bronchitis, n=46, M±m		Control group, n = 22
	at the beginning	in the end	
Lung vital capacity, l	1.8±0.14	2.5±0.26 <sub>p<sub>1</sub>&lt;0.05</sub>	2.5±0.16 <sub>p&lt;0.05</sub>
Forced vital capacity, l	1.7±0.08	2.3±0.17 <sub>p<sub>1</sub>&lt;0.01</sub>	2.4±0.14 <sub>p&lt;0.01</sub>
Forced expiratory volume in 1 second, l	1.5±0.16	2.2±0.10 <sub>p<sub>1</sub>&lt;0.01</sub>	2.3±0.12 <sub>p&lt;0.01</sub>
Stange test result, s	42.0±0.37	59.8±0.31 <sub>p<sub>1</sub>&lt;0.01</sub>	62.4±0.46 <sub>p&lt;0.01</sub>
Gench test result, s	24.2±0.56	31.0±0.36 <sub>p<sub>1</sub>&lt;0.05</sub>	33.4±0.52 <sub>p&lt;0.05</sub>
Chest excursion, cm	3.1±0.33	5.7±0.22 <sub>p<sub>1</sub>&lt;0.01</sub>	6.0±0.32 <sub>p&lt;0.01</sub>
Skibinsky index, conventional units	30.6±0.69	59.8±0.35 <sub>p<sub>1</sub>&lt;0.01</sub>	62.4±0.74 <sub>p&lt;0.01</sub>
Respiratory minute volume, l/min	12.5±0.38	10.4±0.24 <sub>p<sub>1</sub>&lt;0.05</sub>	10.2±0.42 <sub>p&lt;0.05</sub>
Maximum ventilation of the lungs, l/min	47.2±0.41	56.7±0.37 <sub>p<sub>1</sub>&lt;0.05</sub>	58.2±0.84 <sub>p&lt;0.05</sub>
Peak volumetric velocity, l/s	2.6±0.28	4.1±0.30 <sub>p<sub>1</sub>&lt;0.01</sub>	4.3±0.29 <sub>p&lt;0.01</sub>
Maximum volumetric flow rate <sup>25</sup> , l/s	3.1±0.22	4.3±0.15 <sub>p<sub>1</sub>&lt;0.05</sub>	4.4±0.32 <sub>p&lt;0.05</sub>
Maximum volumetric flow rate <sup>50</sup> , l/s	2.3±0.20	2.9±0.16 <sub>p<sub>1</sub>&lt;0.05</sub>	3.2±0.25 <sub>p&lt;0.05</sub>
Maximum volumetric flow rate <sup>75</sup> , l/s	1.5±0.14	1.8±0.19 <sub>p<sub>1</sub>&lt;0.01</sub>	1.9±0.19 <sub>p&lt;0.05</sub>

Legend: p - reliability of differences in indicators between both observation groups in the outcome, p<sub>1</sub> - reliability of changes in indicators in sick adolescents in the course of their yoga exercises.

a clear functional weakness of the respiratory and circulatory systems in adolescents suffering from chronic obstructive bronchitis. This creates the basis for the low resistance of their body to hypoxia<sup>17,18</sup>.

The applied system of yoga exercises had a very positive effect on sick adolescents. The physical exercises used in the work contributed to the development of greater clarity in the control of the breathing process. The tested rehabilitation provided the restoration of the process of complete breathing with a physiological ratio of the duration of the acts of inhalation and exhalation, the optimum depth and frequency of breathing. Regular yogic exercise helped to increase the overall performance of adolescents.

The fulfillment of yogic exercises in patients caused an increase in the vital capacity of the lungs to the optimum state. At the same time, in adolescents with chronic obstructive bronchitis, the value of the forced vital capacity of the lungs significantly increased. The leveling of the phenomena of bronchial obstruction in them promoted the growth of the forced expiration to the norm within 1 second. In the examined patients suffering from chronic obstructive bronchitis, who regularly performed yoga exercises, there was an increase in the level of maximum pulmonary ventilation. The achieved shifts in the indicators taken into account should be considered a marker of normalization of the functional parameters of the respiratory system in patients with an increase in its reserves<sup>19</sup>.

The performed health-improving measures caused positive dynamics of the minute volume of respiration and an increase in its peak volumetric velocity in sick adolescents. Based on this, one can think that their respiratory muscles increased and the patency of large bronchi improved. Achieved during the performance of yoga exercises, positive changes in the level of maximum volumetric velocity in conditions of 25% of the value of the forced vital capacity of the lungs confirmed a significant increase in the degree of patency of large-diameter bronchi<sup>20</sup>. The positive changes that occurred during the healing process in the body of adolescents with chronic obstructive bronchitis of the maximum volumetric velocity under conditions of 50% and 75% of the value of the forced vital capacity of the lungs was a

marker of an increase in the diameter of the lumen of the bronchi with medium and small diameter. The positive changes in the indicators of hypoxic tests and the magnitude of the chest excursion that arose against the background of performing yoga exercises were markers of the normalization of the work of the respiratory center in adolescents and the strengthening of the entire respiratory system. The onset of normalization of the Skibinsky index indicates the activation of the work of the organs of the cardiorespiratory system in sick adolescents with an increase in their resistance to hypoxia<sup>21</sup>.

## CONCLUSION

The presence of chronic inflammation in the bronchi with obstruction symptoms in adolescents violates the sensitivity of the muscles of the bronchial tree and forms their hyperreactivity to any outside influences. Very early in chronic obstructive bronchitis, resistance of the respiratory center to developing hypoxia occurs and the parameters of pulmonary ventilation decrease. This causes the onset of functional weakness of the respiratory and circulatory systems in adolescents. The complex of yogic exercises used in adolescents with chronic obstructive bronchitis almost completely eliminated dysfunctions in the work of the lungs and heart, laying a reliable foundation for their general recovery. Regular performance of yogic exercises normalized the breathing process, eliminated the phenomena of bronchial obstruction, optimizing the entire respiratory act.

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### Conflict of interest

No conflict of interest is declared.

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### Ethics Committee Resolution

The research was approved by the Ethics Committee of Russian State Social University on March 15, 2017 (Protocol No. 3).

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