Original Article

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The role of physical activity in the rehabilitation of patients suffering from mild persistent bronchial asthma

Authors' Contribution:

A – Study Design
B – Data Collection
C – Statistical Analysis
D – Manuscript Preparation
E – Funds Collection

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Abstract

The aim of research is to study the role of physical activity for rehabilitation of patients suffered from mild persistent asthma during their treatment at hospital. The study involved 30 patients being in hospital due to the exacerbation of asthmatic disease. The program of physical rehabilitation is based on the survey results of patients, paying attention to their functional state, rapid assessment of health and physical features of the disease. The use of dosed physical activity while physical rehabilitation of patients suffered from mild persistent asthma has improved functional status of their cardiovascular and respiratory systems, physical performance, quality of life, helped to control the disease.

Keywords: *asthma, patients, physical activity, physical rehabilitation*

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INTRODUCTION

Asthma is a chronic relapsing disease being often in progressive state because of the immunologic or non-immunologic reasons, asthmatic attack develops as mandatory clinical symptom arising from bronchial spasm, mucus hypersecretion and swelling of the bronchial mucosa. This is a chronic respiratory disease that affects 1-18% of population in different countries (300 million in the world), 8-10% of them are disabled, around 250,000 people die of asthma in the world every year [1,2,3,4].

Asthma is a common and potentially serious chronic disease that can be controlled but it cannot be cured. Asthma has a significant impact on people especially on quality of their lives, including attendance and learning performance, it reduces their activity. The goal of treatment and rehabilitation of patients suffered from asthma is to achieve adequate life with normal tolerance to exercise, avoid serious asthma attacks and achieve optimal lung function with the fewest symptoms. As most patients have respiratory dysfunctions and their physical condition is poor physical therapy may have a beneficial effect [5,6,7,8].

At present there is a steady growth of asthmatic disease in Ukraine, it is motivated by environmental pollution, so the number of people with allergies is increasing, nation's gene pool is deteriorating [9, 10,11,12]. All these factors allow considering a bronchial asthma (BA) as an important social and medical problem that requires improvement of diagnostics, development and implementation of comprehensive programs for prevention, treatment and rehabilitation. Hence, it is necessary to develop the modes of physical activity for the patients suffering from asthma, especially in the period of disease exacerbation. These regimes should be applied during the treatment at hospitals.

MATERIAL AND METHODS

The study is involved 30 patients with mild persistent asthma (study group). To compare efficiency of the proposed physical therapy program (PTP) among patients it was formed two control groups included 30 patients each who used only medication (control MT) and traditional methods of exercise (exercise control). The average age of patients was 35.41 ± 1.05 years. Groups of patients were formed by randomization and were compared according to their sex and age. In hospital all patients were in the acute phase of varying degrees of severity. The term of treatment was 14-21 days. At hospital the observations of each patient was being carried out for about 20 days. If the patient left hospital earlier, he continued on performing physical therapy program of rehabilitation and passed the exam in hospital. In general, patient was being observed for 6 months.

All the patients were examined comprehensively. All figures were recorded at the beginning and at the end of the research, besides of surveying there was an additional examination of patients so that it could be found out the quality of interviewees' lives, the data were recorded in six months after physical rehabilitation.

The clinical examination of patients included survey, inspection, revealing of physical changes. The assessment of patients' current status was performed according to the following clinical criteria:

- a number of asthma attacks for a day (NAAD);
- a number of asthma attacks last week (NAAW)
- severity of breathlessness (SV) without asthma attacks on a scale of five point MRC (medical research council dyspnea scale);
- physical activity for a day (FAD);
- asthma control test (Asthma Control Test – ACT).

Respiratory function (RF) was evaluated according to the computer spirography. Spirographic figures were recorded in compliance in accordance with the essential requirements. Three basic functional parameters were selected to make necessary analysis:
- forced expiratory volume for the first second (FEV1);
- vital capacity (VC);
- peak expiratory flow rate (PEF) and its daily fluctuations (DF).

The test connected with the reversibility of bronchial obstruction was done due to the spirometry (TRBO).

The evaluation of physical capacity was performed by immediate performance using a 6-minute step test (6MST) and Ruff'ye's functional test, the degree of motor capacity was identified with the help of ergo-measurement method that allowed us to determine individual exercise tolerance. The value of work (power), expressed in watts being transformed into a value of oxygen consumption was the result of cycling ergo-measurement testing. Finally, the received actual maximum consumption of oxygen was compared with the proper size and level of physical performance being measured as a percentage of the proper maximum consumption of oxygen (PMCO).

With functional tests we evaluated the overall health of patients, the state of individual systems and their spare capacity, especially the adaptation of different systems to physical activity. To do this, we use body mass index, vital index, strength index, Robinson's index, Martin's test and Skibinski's index. The overall level of physical health (OPHL) was identified due to the Apanasenko's methodology. Skibinski's index allows evaluating the function of the respiratory and cardiovascular systems simultaneously it can be also used to determine the state of adequate supply of oxygen indirectly.

To study the quality of life and general health of patients Ukrainian version (made by PhD in medicine Pkhidenko S.) is used by World Health Organization (WHO-100).

RESULTS

Monitoring the rehabilitation process was conducted by the current and landmark controls which ensured adequate treatment expansion and intensification of patient's physical activity. The first level of current control over the process of physical rehabilitation included the most accessible and also very informative clinical research (survey, inspection, palpation, percussion, auscultation, peak flow measuring etc.) which allowed analyzing either the dynamics of individual symptoms, syndromes of disease or overall progress of disease. The second level of control consisted of instrumental methods, including computer spirography, electrocardiography and peak flow measuring. During the evaluation of physical rehabilitation a particular importance had exercise tolerance, which was conducted using the bicycle ergo-measuring.

The severity of the disease was evaluated on the basis of subjective and objective tests. Paying attention to the data of survey and the problems often befalling with patients, we developed a comprehensive physical rehabilitation, based on the results of examination of the functional state, rapid assessment of health status and features of the disease.

The basis of program was a gradual expansion of patient's physical activity. Making the classes we followed a certain sequence purpose of physical training, which consisted of three parts: introduction, main part and final. During the first part of physical training the patients were taught to regulate their volitional management of physical training to control the lasting of breathing during the inspiration and expiration, to behave properly while approaching the attacks of breathlessness. We applied morning hygienic gymnastics and remedial gymnastics (RG), distinct lessons both individually and in small groups. RG included respiratory and general developmental exercises, relaxation exercises while lying, sitting or standing. RG set of exercises lasting up to 25 minutes consisted of 30-35 exercises being performed an average pace.

We focused on prolongation of patients' exhalation being strengthened by additional movements. Warm-up was performed during the introduction, before performing the main part of the load. The main part of exercises occupied 50-70% of all classes. In addition to the previous forms of exercises there were walking trails during the second part of training. Then physical activity was being reduced gradually. Physical exercises were performed not earlier than in 2-3 hours after the last meal, with intervals from 10 to 14 or from 17 to 20 hours. Patients of the main group (the second degree of ability to move) DAM lasting 10-15 minutes consisted of 12-15 exercises. The set of cyclic exercises were used in the second part of rehabilitation systems. Correlation of respiratory and general developmental exercises is 1:2-3. Breathing exercises together with RG showed not only a training effect, but also allowed us to solve several other problems associated with improved drainage function of bronchial tubes: to help eliminate the bronchospasm increasing gas exchange, to relieve tension of the respiratory muscles regulating their collaboration, to uniform ventilation increasing their elasticity, to prevent airway from early closuring and form the correct stereotype of breathing. An important principle of breathing exercises was to achieve the effect of novelty due to the combination of different exercises and introduction of new ones.

One of the most popular methods of training was walking upstairs both at hospitals and in an outpatient setting. For the main group the patients' rate of going up stairs was 16-20 steps a minute, and the rate of walking down stairs was 50-60 steps a minute, training lasted 30 min.

The effectiveness of treatment and the application of the proposed physical rehabilitation program held according to the complex parameters. The study identified the dynamics of clinical status of patients due to the program of physical rehabilitation and other options for treatment of mild persistent asthma. Daytime asthma attacks disappeared in all cases at the end of treatment. Also, shortness of breath did not disturb the patients of main group there was not any physical limitation of patients' daily activity. Meanwhile the patients of control groups felt partly limited physical daily activity after treatment. In a month of treatment, after using the drug therapy weekly, asthma attacks resumed (0.89 ± 0.31 times a week) and after the traditional methods of exercise asthma attacks occurred 0.75 ± 0.28 times a week, which almost did not happen after the program of physical rehabilitation (0.13 ± 0.33 times a week). It demonstrates the complete control of the disease while using PRP (ACT grew from 13.47 ± 0.32 to 23.57 ± 0.30 points), the lack of control while using traditional methods of exercise (ACT decreased from 13.95 ± 0.35 to 19.36 ± 0.31 points) and there is no control while using only medicines (ACT increased from 12.85 ± 0.47 to 17.22 ± 0.41 points).

Significant improvement of lung function occurred in patients with mild severity of asthma after taking part in the program of physical rehabilitation that was proved by the results shown in table 1. For example, in the study group forced expiratory volume for first second increased from 69.22 ± 3.45 to 88.60 ± 3.22% ($p<0.001$), vital capacity – from 74.36 ± 3.61 to 95.18 ± 3.46% ($p<0.001$) and peak expiratory flow rate – from 69.35 ± 4.33 to 88.77 ± 4.12% ($p<0.01$). Similar changes occurred in patients of the control group where forced expiratory volume for the first second increased from 71.45 ± 3.36 to 82.17 ± 3.23% ($p<0.05$) and vital capacity – from 75.36 ± 3.72 to 86.66 ± 3.44% ($p<0.001$). Statistically significant changes in the patients of control group who were being treated with medication did not happen. Significant changes happened to the indicators of bronchial reactivity, which statistically decreased after the implementation of physical rehabilitation program: reversible airflow obstruction decreased from 22.31 ± 1.46 to 9.70 ± 1.41% ($p<0.001$), daily fluctuations of peak expiratory flow rate decreased from 29.47 ± 1.62 to 9.30 ± 1.73% ($p<0.001$). The same happened to the patients of control groups: reversible airflow obstruction decreased from 21.52 ± 1.84 to 12.23 ± 1.93% ($p<0.01$) daily fluctuations of peak expiratory flow rate decreased from 28.38 ± 1.73 to 11.35 ± 1.71% ($p<0.001$) in the patients treated with medication the reversible airflow obstruction decreased from 23.49 ± 2.62 to 15.66 ± 2.43% ($p<0.05$), daily fluctuations of peak expiratory flow rate reduced from 30.43 ± 2.74 to14.49 ± 2.85% ($p<0.001$).

The use of physical rehabilitation program caused some increasing of patients' functionality and it was reflected by increasing in functional tests (Stange's test shows the growth of indicators from 33.59 ± 1.57 to 48.71 ± 1.50 s ($p<0.001$) and Ghencea's sample – from 17.25 ± 1.36 to 25.88 ± 1.32 s ($p<0.001$) and Skibinski's index – from 13.63 ± 1.82 to 36.12 ± 1.62 conv. units ($p<0.001$). Similar changes occurred in the patients of the control group while using traditional methods of exercises, which registered an increase in Stange's test from 34.63 ± 1.45 to 43.29 ± 1.54 s ($p<0.001$) and Skibinski's index – from 14.24 ± 1.67 to 30.62 ± 1.56 conv. units ($p<0.001$). Treatment only with medicines caused some positive changes in these indicators too, so Skibinski's index increased from 12.28 ± 2.45 to 20.02 ± 2.40 conv. units ($p<0.05$), Stange's sample – from 32.42 ± 2.13 to 38.90 ± 2.06 s ($p<0.05$).

In general it should be noted that exercise therapy for the patients in the main and control groups led to normalization of respiratory function. According to Skibinski's index the state of oxygen supply for patients after using the program of physical rehabilitation was "good", but using only traditional exercise therapy and drugs it was "satisfactory".

The evolution of physical capacity among the patients suffered from mild asthma during the treatment in hospital is given in Table 2. While implementing the program of physical rehabilitation the exercise tolerance of men increased from 75.12 ± 5.36 to 134.4 ± 6.12 W ($p<0.001$), in accordance with the growth of appropriate maximal oxygen consumption from 38.94 ± 3.62 to 69.70 ± 3.71% ($p<0.001$). These patients began walking 577.4 ± 53.34 m distance for 6 minutes (before treatment – 322.6 ± 52.45 meters, $p<0.01$), which was 82.23 ± 3.36% from the proper value (before treatment – 45.94 ± 3.53%, $p<0.001$). According to Ruff'ye's Index physical capacity of the patients decreased from 16.11 ± 1.54 to 5.56 ± 1.25 conv. units ($p<0.001$), thus improved physical capacity was on a "good" level (though at the beginning of treatment it was "unsatisfactory").

Similar changes occurred with physical performance of men while treating them with the help of traditional methods of exercise therapy. So their exercise tolerance increased from 74.16 ± 5.38 to 104.5 ± 5.12 W ($p<0.001$), in accordance with the growth of appropriate maximal oxygen consumption from 38.05 ± 3.46 to 53.65 ± 3.54% ($p<0.01$), figures of 6-minute step test increased from 315.5 ± 55.22 (45.12 ± 3.68% of the proper size) to 444.8 ± 51.32 m (63.62 ± 3.45% of the proper value, $p<0.05$). According to Ruff'ye's index physical abilities improved and became "average" (falling down from 15.23 ± 1.72 to 8.96 ± 1.36 conv. units, $p<0.05$). There were some changes in physical capacity of male patients being treated only with drugs, their exercise tolerance increased from 73.83 ± 6.22 to 95.98 ± 5.23 W ($p<0.05$), in accordance with the growth of appropriate maximal oxygen consumption from 37.85 ± 4.47 to 49.21 ± 4.32%, figures of 6-minute step test increased from 305.6 ± 67.15 (44.72 ± 4.32% of the proper size) to 397.2 ± 61.42 m (58.14 ± 4.58% of the proper value, $p<0.05$). According to Ruff'ye's index physical capability of these men improved to the "medium" level (reduced from 15.03 ± 1.97 to 9.95 ± 1.45 conv. units, $p<0.05$).

It is necessary to emphasize that while applying the program of physical rehabilitation and exercise therapy the men improved their possibilities to move from the second degree to the third one but during the medical treatment possibilities of patients to move did not change remaining on the first level.

The evolution of physical efficiency among the women suffered from mild asthma is given in Table 3. After the program of physical rehabilitation being applied, women's tolerance to the physical activity increased from 60.42 ± 5.51 to 108.1 ± 5.25 W ($p<0.001$), it corresponded to the growth of appropriate maximal oxygen consumption from 36.71 ± 3.46 to 65.71 ± 3.39% ($p<0.001$). These patients began walking 526.9 ± 61.24 m (before treatment – 294.4 ± 60.32 meters, $p<0.01$) distance for 6 minutes which was 77.95 ± 3.35% of the proper value (before treatment – 43.55 ± 3.65%, $p<0.001$). Ruff'ye' index dropped from 17.62 ± 1.33 to 6.08 ± 1.42 conv. units ($p<0.001$), indicating that women were capable of improving their physical activity to the "average" level (at the beginning of treatment it was "unsatisfactory").

Table 1. Dynamics of respiratory function and respiratory functional tests in patients suffering from mild persistent asthma (Mean±SD).

Indexes	Groups of patients with mild persistent asthma					
	control MT		exercise control		study group	
	At the beginning	At the end	At the beginning	At the end	At the beginning	At the end
FEV_1 [%]	68.41±4.38	75.25±4.46	71.45±3.36	82.17±3.23*	69.22±3.45	88.60±3.22***
VC [%]	73.18±4.54	80.50±4.32	75.36±3.72	86.66±3.44*	74.36±3.61	95.18±3.46***
PEF [%]	67.57±5.36	74.33±5.21	70.66±4.64	81.26±4.51	69.35±4.33	88.77±4.12**
TRBO [%]	23.49±2.62	15.66±2.43*	21.52±1.84	12.23±1.93**	22.31±1.46	9.70±1.41***
PEF DF [%]	30.43±2.74	14.49±2.85***	28.38±1.73	11.35±1.71***	29.47±1.62	9.30±1.73***
Skibinski's index [conv.units]	12.28±2.45	20.02±2.40*	14.24±1.67	30.62±1.56***	13.63±1.82	36.12±1.62***
Stange's test [s]	32.42±2.13	38.90±2.06*	34.63±1.45	43.29±1.54***	33.59±1.57	48.71±1.50***
Ghencea's sample [s]	16.57±1.76	19.88±1.44	18.53±1.48	22.05±1.32	17.25±1.36	25.88±1.32***

* p<0.05, ** p<0.01, *** p<0.001

Table 2. The evolution of physical performance and overall assessment of physical health in men suffering from mild persistent asthma (Mean±SD).

Indexes	Groups of patients with mild persistent asthma					
	control MT		exercise control		study group	
	At the beginning	At the end	At the beginning	At the end	At the beginning	At the end
Exercise tolerance [W]	73.83±6.22	95.98±5.23**	74.16±5.38	104.5±5.12***	75.12±5.36	134.4±6.12***
PMCO [%]	37.85±4.47	49.21±4.32	38.05±3.46	53.65±3.54**	38.94±3.62	69.70±3.71***
6MST [m]	305.6±67.15	397.2±61.42*	315.5±55.22	444.8±51.32	322.6±52.45	577.4±53.34**
6MST [% from *proper value]*	44.72±4.32	58.14±4.58*	45.12±3.68	63.62±3.45*	45.94±3.53	82.23±3.36***
Ruff'ye's index [conv. units]	15.03±1.97	9.95±1.45*	15.23±1.72	8.96±1.36*	16.11±1.54	5.56±1.25***
OPHL [points]	4.11±1.86	6.78±1.63	4.44±1.64	8.21±1.48	4.75±1.42	11.88±1.37***

* p<0.05, ** p<0.01, *** p<0.001

Table 3. The evolution of physical performance and overall assessment of physical health in women suffering from with mild persistent asthma (Mean±SD).

Indexes	Groups of patients with mild persistent asthma					
	control MT		exercise control		study group	
	At the beginning	At the end	At the beginning	At the end	At the beginning	At the end
Exercise tolerance [W]	58.75±5.28	76.38±5.42*	59.46±6.64	83.84±6.12**	60.42±5.51	108.1±5.25***
PMCO [%]	35.12±3.62	45.66±3.55*	35.77±4.53	50.44±4.26*	36.71±3.46	65.71±3.39***
6MST [m]	276.3±66.54	359.1±62.34*	280.3±63.43	395.2±61.24	294.4±60.32	526.9±61.24**
6MST [% from *proper value]*	41.94±3.72	54.52±3.46*	42.74±3.96	60.26±3.96**	43.55±3.65	77.95±3.35***
Ruff'ye's index [conv. units]	15.83±1.53	10.55±1.33*	16.68±1.85	9.81±1.73**	17.62±1.33	6.08±1.42***
OPHL [points]	2.63±1.43	5.13±1.27	2.82±1.81	7.28±1.68	2.93±1.38	10.55±1.32***

* p<0.05, ** p<0.01, *** p<0.001

Similar changes in physical performance were recorded in women being treated with the help of methods of traditional exercise, their exercise tolerance increased from 59.46 ± 6.64 to 83.84 ± 6.12 W (p<0.01), maximum consumption of oxygen increased from 35.77 ± 4.53 to 50.44 ± 4.26% (p<0.05), 6-minute step test went up from 280.3 ± 63.43 (42.74 ± 3.96% of proper size) to 395.2 ± 61.24 m (60.26 ± 3.96% of proper value, p<0.01). Ruff'ye's index decreased from 16.68 ± 1.85 to 9.81 ± 1.73 cu (p<0.05) and changed from "poor" into "average". The women being treated only with medicines had the following changes of physical capacity: exercise tolerance increased from 58.75 ± 5.28 to 76.38 ± 5.42 W (p<0.05), maximum consumption of oxygen increased from 35.12 ± 3.62 to 45.66 ± 3.55% (p<0.05), 6-minute step test – from 276.3 ± 66.54 (41.94 ± 3.72% of the proper size) to 359.1 ± 62.34 m (54.52 ± 3.46% of the proper value, p<0.05). According to the Ruff'ye's index women's physical capacity changed from "poor" to "fair" (it went down from 15.83 ± 1.53 to 10.55 ± 1.33 cu p<0.05). In general, it is necessary to emphasize

that women's motion possibilities increased from the second to the third degree only after applying the program of physical rehabilitation for patients suffering from mild asthma.

Analysis of physical health according to Apanasenko's methodology showed substantial and statistically significant improvement of physical health in men after applying the program of physical rehabilitation, their performance increased from 4.75 ± 1.42 to 11.88 ± 1.37 points ($p<0.001$) and while treating with traditional methods of exercise their performance increased from 4.44 ± 1.64 to 8.21 ± 1.48 points, but using only medicines physical capacity of patients changed from 4.11 ± 1.86 to 6.78 ± 1.63 points. Similar coincidence was found in women while applying the program of physical rehabilitation: general assessment of physical health increased from 2.93 ± 1.38 to 10.55 ± 1.32 points ($p<0.001$), using the traditional methods of exercise – from 2.82 ± 1.81 to 7.28 ± 1.68 points , during the drug therapy – from 2.63 ± 1.43 to 5.13 ± 1.27 points.

We also saw the dynamics of quality the patients' lives. After treating, the quality of life among the patients of control group who were treated with medication changed positively. Thus, compared with the initial state the level of independence increased from 8.14 ± 0.24 to 8.95 ± 0.26 points ($p<0.05$), the range of "social relations" went up from 8.06 ± 0.23 to 8.87 ± 0.25 ($p<0.05$), the range of "environmental" increased from 9.10 ± 0.25 to 10.01 ± 0.27 ($p<0.05$) and overall quality of life improved from 62.85 ± 2.43 to 77.68 ± 2.12 points ($p<0.001$). In the control group, using traditional methods of exercise, positive and statistically significant dynamics was in all range of life quality: physical sector increased from 9.22 ± 0.25 to 13.18 ± 0.22 points, psychological sphere – from 13.05 ± 0.42 to 18.66 ± 0.36 points ($p <0.001$) level of independence – from 9.24 ± 0.21 to 13.21 ± 0.23 points ($p <0.001$), social relations – from 9.11 ± 0.15 to 13.03 ± 0.14 points ($p <0.001$), environment – from 10.23 ± 0.17 to 14.63 ± 0.13 points ($p <0.001$), spiritual sphere – from 14.72 ± 0.43 to 17.96 ± 0.37 points ($p <0.001$) and overall quality of life – from 64.06 ± 1.75 to 91.75 ± 1.84 points ($p<0.001$). These 5 indicators (physical sphere, psychological aspect, the level of independence, social relationships, environment) from 7 ones remained below normal values, so it was proved that the respondents were relatively satisfied with their lives.

The most significant dynamics of patients' life quality was identified in the main group of the respondents. The use of physical rehabilitation program patients' physical capability considerably increased from 8.71 ± 0.28 to 17.50 ± 0.22 points ($p<0.001$),their psychological state improved from 12.23 ± 0.45 to 19.57 ± 0.36 points ($p<0.001$), degree of independence went up from 8.66 ± 0.19 to 16.28 ± 0.12 points ($p<0.001$), social relations increased from 8.94 ± 0.16 to 16.10 ± 0.14 points ($p<0.001$), environment – from 9.71 ± 0.18 to 16.99 ± 0.15 points ($p<0.001$), spiritual sphere of their life improved from 14.35 ± 0.47 to 18.94 ± 0.39 points ($p<0.001$) and overall quality of life changed from 63.62 ± 1.88 to 112.0 ± 1.63 points ($p<0.001$). Achieved quality of life for our patients was appropriate to normal values. Patients restored and strengthened their psychological state.

The effectiveness of our physical rehabilitation program for the patients suffering from mild persistent asthma is given in the Table. 4. Effects of treatment and physical rehabilitation program for the current state of patients was equally effective (according to the changes of numbers of asthma attacks a day, severity of dyspnea, physical activity during the day). However, the control of disease was more significant after applying physical rehabilitation program, it was indicated by offset MPA (ACT) – 10.10 ± 0.95 points (control during the exercise therapy decreased by 6.00 ± 1.05 points, $p<0.01$, control while treating with drugs decreased by 4.37 ± 1.15 points, $p<0.001$).

Table 4. Achieved effects (the difference between the beginning and end of the study) in patients suffering from mild persistent asthma (Mean±SD).

Indexes	Groups of patients with mild persistent asthma		
	control MT	exercise control	study group
Clinical			
NAAD [number]	-2.25±0.32	-2.12±0.27	-2.18±0.24
SV [points]	-1.32±0.43	-1.60±0.32	-1.73±0.30
FAD [points]	-0.80±0.46	-1.38±0.35	-1.30±0.31
Control flow asthma			
ACT [points]	4.37±1.15	6.00±1.05	10.10±0.95**###
Respiratory function			
FEV_1 [%]	6.84±3.42	10.72±3.53	19.38±4.14 #
VC [%]	7.32±3.12	11.30±3.36	20.82±4.05 ##
PEF [%]	6.76±2.53	10.60±3.47	19.42±3.26 ##
TRBO [%]	-7.83±2.45	-9.29±2.32	-12.61±2.33
PEF DF [%]	-15.94±3.18	-17.03±3.15	-20.17±3.24
Physical capacity			
Men			
Exercise tolerance [W]	22.15±9.45	30.41±10.23	59.34±9.86 * #
6MST [m]	91.68±32.37	129.3±36.05	254.8±38.45 *##
Ruff'ye's index [conv. units]	-5.08±1.23	-6.27±1.35	-10.55±1.42 *##
Women			
Exercise tolerance [W]	17.63±8.53	24.38±10.16	47.73±11.57 #
6MST [m]	82.89±31.26	114.9±36.46	232.5±39.42 *##
Ruff'ye's index, conv. units	-5.28±1.13	-6.87±1.32	-11.54±1.41 *##
Physical health by Apanasenko GL			
OPHL men [points]	2.67±0.84	3.77±0.81	7.13±0.92 **##
OPHL women [points]	2.50±0.81	4.46±0.86	7.62±0.90 *###
Quality of life			
Physical sphere [points]	0.80±0.97	3.96±1.84	8.79±1.75 ###
Psychological sphere [points]	1.15±0.88	5.61±2.25	7.34±1.92 ##
The level of independence [points]	0.81±0.75	3.97±1.74	7.62±1.82 ##
Social relations [points]	0.81±0.72	3.92±1.63	7.16±1.60 ###
Environment [points]	0.91±0.68	4.40±1.86	7.28±1.76 ##
The spiritual sphere [points]	0.92±0.74	3.24±1.05	4.59±1.07 ##
The total QOL and health [points]	15.23±2.96	27.59±5.96 #	48.88±5.85**###

– statistically significant differences compared with the control group treated with medication (# $p<0.05$, ## $p<0.01$, ### $p<0.001$) * – compared with the patients of control group being treated with the help of exercise therapy (* $p<0.05$, ** $p<0.01$, *** $p<0.001$)

DISCUSSION

Physical rehabilitation program was more effective for restoring the state of respiratory function. Using it caused the increase of forced expiratory volume in a second by 19.38 ± 4.14% (control of exercise therapy – by 10.72 ± 3.53%, control of medication – by 6.84 ± 3.42%, $p<0.05$), vital capacity – by 20.82 ± 4.05% (control of exercise therapy – by 11.30 ± 3.36%, control of medication – by 7.32 ± 3.12%, $p<0.01$), peak expiratory flow rate increased by19.42 ± 3.26% (control of exercise therapy – by 10.60 ± 3.47 % control with medication – by 6.76 ± 2.53%, $p<0.01$). Also, the application of physical rehabilitation program more significantly decreased reactivity of bronchi, which showed the decrease of reversibility of bronchial obstruction by 12.61 ± 2.33% (control of exercise therapy – by 9.29 ± 2.32%, control with medication – by 7.83 ± 2.45%, $p<0.01$) and daily fluctuations in peak expiratory flow rate – by 20.17 ± 3.24% (control during exercise therapy – by 17.03 ± 3.15%, control with medication – by 15.94 ± 3.18%). These

shifts of indicators while performing the program of physical rehabilitation, compared with the control group being treated with drugs, were statistically more significant.

Men indicators of physical performance after applying physical rehabilitation had following changes: exercise tolerance increased by 59.34 ± 9.86 W (control of exercise therapy – by 30.41 ± 10.23 W, $p<0.05$, control with medication – by 22.15 ± 9.45 W $p<0.05$), 6-minute step test increased by 254.8 ± 38.45 m (control of exercise therapy – by 129.3 ± 36.05 meters, $p<0.05$, control with medication – by 91.68 ± 32.37 meters, $p<0.01$) and Ruff'ye' index decreased by 10.55 ± 1.42 conv. units (control of exercise therapy – by 6.27 ± 1.35 conv. units, $p<0.05$, control with medication – by 5.08 ± 1.23 conv. units, $p<0.01$).

In women, rates of physical performance after applying the program of physical rehabilitation had such shifts as: exercise tolerance increased by 47.73 ± 11.57 W (control of the exercise therapy – by 24.38 ± 10.16 W control with medication – by 17.63 ± 8.53 W, $p<0.05$) 6 step minute test increased by 232.5 ± 39.42 m (control of exercise therapy – by 114.9 ± 36.46 meters, $p<0.05$, control with medication – by 82.89 ± 31.26 meters, $p<0.01$), and Ruff'ye' index decreased by 11.54 ± 1.41 conv. units (control of exercise therapy – by 6.87 ± 1.32 conv. units, $p<0.05$, control with medication – by 5.28 ± 1.13 conv. units, $p<0.01$). Thus, the achieved effects of physical performance indicators while applying the program of physical rehabilitation were more significant in comparison with control groups being treated with drugs.

While applying the program of physical rehabilitation the restoration effects of physical health, according to the overall assessment, were also more pronounced. According to Apanasenko' method physical health condition of men improved by 7.13 ± 0.92 points (during the control of exercise therapy – by 3.77 ± 0.81 points, $p<0.01$ control with medication – by 2.67 ± 0.84 points, $p<0.01$) in women – by 7.62 ± 0.90 points (during the control of exercise therapy – by 4.46 ± 0.86 points, $p<0.05$ during the control with medication – by 2.50 ± 0.81 points, $p<0.001$). Compared with control groups achieved effect connected with recovery of patients while applying the program of physical rehabilitation was statistically significant in both men and women.

Data analysis showed the different effectiveness and impact on quality of life during the application of physical rehabilitation program. Using our program of physical rehabilitation patients improved their physical health by 8.79 ± 1.75 points (during control of exercise therapy – by 3.96 ± 1.84 points, control with medication – by 0.80 ± 0.97 points, $p<0.001$), psychological state of patients was improved by 7.34 ± 1.92 points (during the control of exercise therapy – by 5.61 ± 2.25 points, $p<0.05$, control with medication – by 1.15 ± 0.88 points, $p<0.01$), independence – by 7.62 ± 1.82 points (during the control of exercise therapy – by 3.97 ± 1.74 points, control during the drug treatment – by 0.81 ± 0.75 points, $p<0.01$), social relations – by 7.16 ± 1.60 points (control of exercise therapy – by 3.92 ± 1.63 points, control with medication – by 0.81 ± 0.72, $p<0.001$), environment – by 7.28 ± 1.76 points (during the control of exercise – by 4.40 ± 1.86 points, $p<0.05$, control while treating with medication – by 0.91 ± 0.68 points, $p<0.01$), spiritual sphere – by 4.59 ± 1.07 points (during the control of exercise therapy – by 3.24 ± 1.05 points, control with medication – by 0.92 ± 0.74 points) and overall quality of life increased by 48.88 ± 5.85 points (during the control of exercise therapy – by 27.59 ± 5.96 points, $p<0.01$, control with medication – by 15.23 ± 2.96 points, $p<0.001$). In all cases achieved shift indicators of life quality while applying the program of physical rehabilitation were higher and statistically they were different from the effects having been achieved in the control group while treating them with medicines.

The use of physical rehabilitation program allowed to reduce the duration of salable period in patients suffering from mild asthma for 5.44 ± 0.46 days, which statistically was fewer than in the control group being treated with medication (9.54 ± 0.59 days ($p<0.001$)) and in the control group during the exercise therapy (7.62 ± 0.53 days ($p<0.01$)). While applying the program of physical rehabilitation, compared with the group of patients treated only with drugs, duration of disease period was reduced by 4.10 ± 0.36 days.

To set the length of gymnastic period we analyzed daily value of physical performance for men and women within 20 days. The distance increased by 10% in 8 days in the men of the main group (355.2 ± 58.5), in the control group while using exercise therapy it happened in 11 days (346. ± 61.0 m), in the control group using the treatment with drugs it was in 12 days (335.4 ± 66.2 m). In the women of study group 10-percent increase of the distance was recorded in 9 days (324.75± 3.2), in the control group, using the exercise therapy – in 11 days (30.5±62.2 m) and in the control group using the treatment with drugs – in 13 days (302.3±65.1 m).

In each group of the men suffering from mild asthma the average calculations showed that in the control group treated with medication the length of gymnastic period was 12.28 ± 0.55 days, in the control group treated with exercise therapy – 10.72 ± 0.57 days and in the study group – 7.52 ± 0.51 days (compared with the control group of patients treated with medication $p<0.001$, with control group of patients treated with exercise therapy – $p<0.001$). That is, due to the application of physical rehabilitation program for men the duration of gymnastic period of disease was reduced by 4.16 ± 0.38 days compared with the group of patients treated with medication. The duration of gymnastic period in the female control group treated with medication was 12.64 ± 0.56 days in the control group treated with exercise therapy – 11.08 ± 0.59 days and in the study group – 7.88 ± 0.45 days (compared with the control group treated with medication $p<0.001$ with control exercise – $p<0.001$). Due to the application of physical rehabilitation program gymnastic duration period of the disease in women was reduced by 4.76 ± 0.41 days compared with the group of patients treated with medication.

Thus, using the program of physical rehabilitation for the patients suffering from mild persistent asthma allowed us to achieve complete control of disease in a month after treatment (ACT – 23.57 ± 0.30 points), while the use of traditional methods of exercise and drug treatment allowed controlling only partially (ACT – 19.36 ± 0.31 points) or without any control (ACT – 17.22 ± 0.41 points). The program of physical rehabilitation significantly improved respiratory function: forced expiratory volume increased up to 88.60 ± 3.22% in 1 second (in the control group of patients while using the exercise therapy – to 82.17 ± 3.23%, with medication – to 75.25 ± 4.46%), physical capacity of patients: men's exercise tolerance grew to 134.4 ± 6.12 W (in the control group of patients while using the exercise therapy to 104.5 ± 5.12 W in the control group of patients treated with medication – to 95.98 ± 5.23 W), women's exercise tolerance increased to 108.1 ± 5.25 W (in the control group of patients while using the exercise therapy – to 83.84 ± 6.12 W, in the group of patients treated with medication – to 76.3 8 ± 5.42 W), the duration of asthma attacks was reduced to 5.44 ± 0.46 days, gymnastics period of the disease was reduced to 7.52 ± 0.51 days for men and to 7.88 ± 0.45 days for women, allowing them to train sooner compared with other treatments. The use of physical rehabilitation program in clinical situation greatly improved physical health and life quality of patients that was reflected in the growth of overall assessment of physical health in men to 11.88 ± 1.37 points (in the control group of patients while using the exercise therapy – to 8.21 ± 1.48 points, in the control group of patients treated with medication – to 6.78 ± 1.63 points), in the women – to 10.55 ± 1.32 points, (in the control group of patients while using the exercise therapy – to 7.28 ± 1.68 points, in the patients treated with medication – to 5.13 ± 1.27 points) and the rate of overall quality of life increased to 112.0 ± 1.63 points (in the control group of patients while using the exercise therapy – to 91.75 ± 1.84 points, in the patients treated with medication – to 77.68 ± 2.12 points) and they achieved full satisfaction with the quality of their lives.

Physical rehabilitation programs, based on a gradual increase of physical activity, are developed for the patients to improve their physical fitness, neuromuscular coordination and self-confidence. Although aerobic exercise can provoke bronchoconstriction in patients, regular physical activity and exercise are considered to be important components of rehabilitation program. Taking up physical activity belongs to one of the important of the therapy [13,14,15,16,17]. However, fear of the dyspnea restricts a lot of patients to take part in physical activity, besides the low level of physical activity leads to the low level of physical training.

Increasing the strength of respiratory muscles can reduce the intensity of breathlessness and improve exercise capacity. Thus, the dosed increase of physical activity and respiratory muscle training should be compulsory for patients while performing the program of physical rehabilitation. At the end of the study, patients of the main group had a positive trend of decrease in clinical symptoms of asthma attacks. Asthma attacks became less intense, and their frequency was reduced, cough was being accompanied by the discharge of phlegm, wheezing in the lungs disappeared, patients slept better and noticed that they could use bronchodilators less, medium performance peak of expiratory flow and forced expiratory volume in the first second were higher than in the patients of control group. Exercise improved physical performance, quality of life, improved cardiopulmonary endurance and fitness.

The result of physical activity was observed in dynamics during the rehabilitation, allowing us to determine the objective effectiveness of the proposed program.

CONCLUSIONS

Using the dosed physical activity in programs of physical rehabilitation for the patients suffering from mild persistent asthma can improve their functional state of cardiovascular and respiratory systems, physical performance, quality of life, promote their mental stability, give them confidence in the future and help to control the disease.

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