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Effect of physical activity on peak expiratory flow and the 6-minute walk test

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Abstract

The study conducted research aimed at assessing the influence of physical activity on peak expiratory flow (PEF) and the 6-minute walk test (6MTW). The research was carried out at the Department of Systemic Rehabilitation - Post Covid at the Pj-Med Rehabilitation Hospital in Popielówek from June 2021 to April 2022.

The inclusion criteria for the studies was a positive PCR test performed up to one year after the end of treatment. Exclusion criteria - active inflammation (CRP <5 or increasing CRP level), acute pulmonary embolism, heart failure with impaired left ventricular ejection fraction (LVEF <35%) without cardioverter-defibrillator protection, unstable disease outside the circulatory system, unstable coronary artery disease, uncontrolled arrhythmias.

The entire rehabilitation program lasted 6 weeks. The beginning of rehabilitation services was on average 4 months after the positive PCR result (min. 1 month and max. 11 months).

A statistically significant difference was observed in the PEF parameter and in the 6MTW test before and after rehabilitation.

Keywords: covid, rehabilitation, PEF, efficiency, FEV1

Introduction:

Each person infected with COVID-19 has been contaminated in very different ways. In our study, 50 patients (n50) were hospitalized due to illness. Very often, patients complained of impaired taste, smell, dyspnoea, paresthesia of the extremities, memory loss, chronic fatigue, and malaise/dyspnoea after exercise. Only in 12 patients (n12) there was no damage to the pulmonary parenchyma. 15 patients (n15) have a damaged diaphragm. The infection wreaks havoc on the body in many ways, including most often it affects the degeneration of the respiratory system. It causes a reduction in efficiency and physical fitness. This causes the patient to fear for his health and life, which becomes a problem in everyday functioning.

| Number of people (n74) | Course of illness |
|---------------------------|-------------------------|
| n50 | Oxygen administered |
| n7 | Ventilator interference |
| n8 | Poor taste |
| n12 | Poor sense of smell |

Tab. 1 Analysis of the course of the disease, source – own study

Test material:

In the study age 74 people (n74, including 33 women (mean age 64) and 41 men (mean age 60)). The mean age of the group is 64. Min. Age 25, max. 86 years (SD 11.04). Mean group height up to 1.68 m (SD 0.09) The mean starting weight of 26 kg is 83 kg (SD) and the final weight is 77 kg (SD, 1).

Research methods

The patients underwent a dynamic spirometry test in which the PEF parameter and forced expiratory volume in one second (FEV1) were analyzed. The procedure was performed in each of them at 8.30 am. Spirometry was performed twice: on the weekday after admission and the day before departure. During the measurement, the patient sat and was to perform:

- deep inhale without a mouthpiece,
- while inhaling, place the mouthpiece in your mouth, hold it with your mouth and rest it on the mouthpiece so that the air does not come out through the sides,
- perform the maximum exhalation until the parameter 0 on the spirometer graph is reached,
- take a deep breath again with the mouthpiece.

Additionally, 6MTW was carried out (the designated corridor length was 35m, and the study was carried out on each patient at 11.00 am). The test was performed 4 times: the day after admission to the hospital, after 2 weeks of stay, after 4 weeks of stay, and the day before the patient's discharge from the ward. Prior to the test, the patient's heart rate (HR), arterial oxygen saturation (SpO2), and blood pressure (RR) were measured. In order for the test to be performed, the level of the analyzed parameters could not exceed, RR 140/90 mmHg, SpO2 <90%, and resting HR >100 / min. Based on the obtained result, the MET metabolic coefficient was converted using the formula (Fig. 2.4).

On the basis of the obtained results (FEV1 and MET), the patients were qualified for the appropriate model of pulmonary rehabilitation (A, B or C).

MODEL A [1]

- exercises once a day lasting 30 minutes before noon,
- endurance training of a continuous type on an ergometer/treadmill to the patient's training heart rate,
- resistance training
- station training,
- walks,
- nebulization,
- tapping the chest.

MODEL B

- exercises once a day lasting 30 minutes before noon,
- endurance training of the continuous type (for patients with good exercise tolerance) or interval training (for patients with moderate exercise tolerance) on an ergometer / treadmill to the patient's training heart rate,
- resistance training
- station training,
- walks,
- nebulization,
- tapping the chest.

MODEL C

- exercises twice a day for 30 minutes - in the morning and in the afternoon
- training on an ergometer / treadmill to the patient's training pulse,
- walks,
- nebulization,
- tapping the chest.

| | | n74 | Admission to hospital: |
|--------------------------------------------------------------------------------------------------------------------------------------------------|-----------|------------|-------------------------------|
| Relaxation according to Schultz (30 min), Nordic walking (30 min), breathing exercises (30 min), training on a cyclo-ergometer. PEF, 6MWT | PEF, 6MWT | n74 | The first day after admission |
| | 6MWT | n74 | Two weeks after admission |
| | 6MWT | n71 | Four weeks after admission |
| | PEF, 6MWT | n56 | Six weeks after admission |

Tab. 2 Rehabilitation program, source – own study.

The formula for the MET at a distance of less than 320 m:

$$\text{Walking speed (v)} = \frac{\text{lenght (m)} \times 10}{1000}$$

Fig.1 [1]

$$\text{MET} = \frac{[(\text{walking speed} \times 1,667) + 3,5]}{3,5}$$

fig.2 [1]

The formula for the MET at a distance of less than 320 m:

$$\text{Walking speed (v)} = \frac{\text{lenght (m)} \times 10}{1000}$$

Fig.3 [1]

$$\text{MET} = -0,0971v^3 + 1,5021v^2 - 5,3762v + 7,9532$$

Fig.4 [1]

The determination of the heart rate zones during exercise was performed using the Karvoven method, from the formula: [2]

$$(\text{maximum heart rate} - \text{resting heart rate}) \times \text{intensity} + \text{resting heart rate}$$

$$\text{Maximum heart rate: } 208 - 0.7 \times \text{age}$$

Classes were conducted 6 days a week, except for Sundays, for 6 weeks. From Monday to Friday, patients participated in Schultz relaxation exercises (30 min), breathing exercises, exercises to strengthen the abdominal muscles (30 min), Nordic walking classes (30 min), and training on a bicycle or treadmill (training conducted to the patient's training pulse).

During the 6th day of training, the patients participated only in training on a bicycle ergometer.

At the beginning of the analysis, the compliance of the data with the normal distribution was checked using the Shapiro Wilk test and the Kolmogorov-Smirnow test. The statistical evaluation of ANOVA, Pearson's r linear dependence, and the Student's T-Test for dependent groups were used. The level of statistical significance was set at <0.05.

Results:

There was a statistically significant difference in peak expiratory flow (PEF) performed before and after rehabilitation (Fig. 5). The mean before the group was 5.21 (SD 2.37), and after 5.68 (SD 2.61).

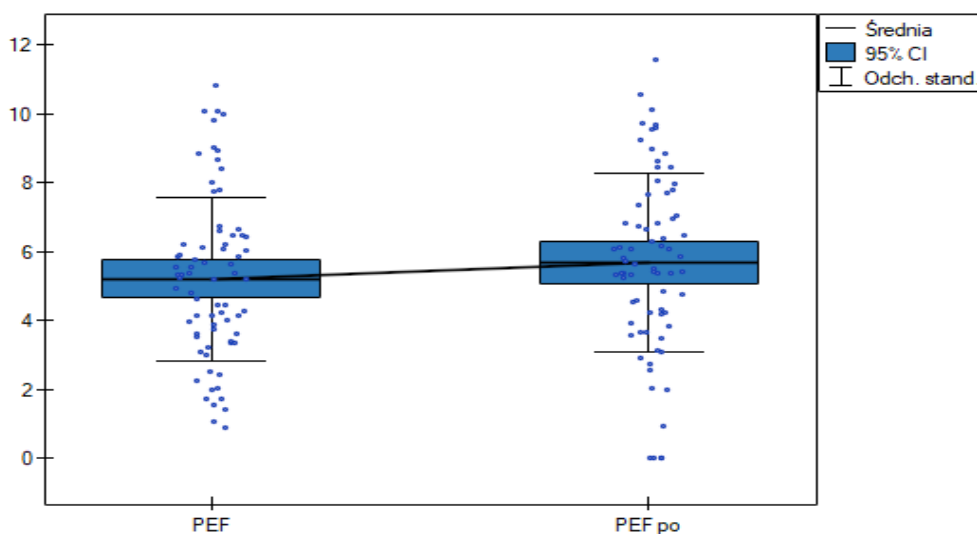
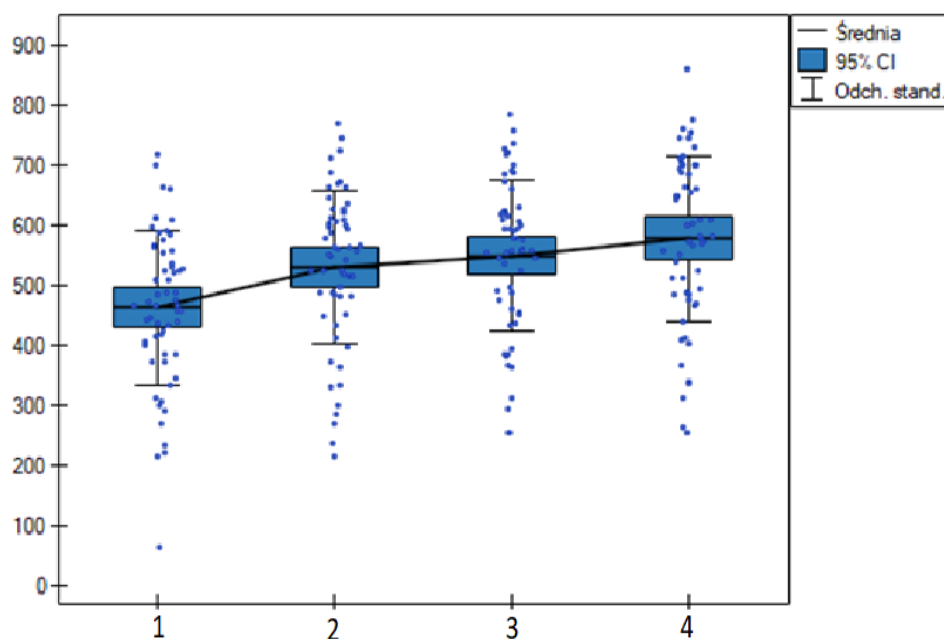


Fig.5. Comparison of PEF before to PEF after rehabilitation, analysis with Student's T-test, significance level $p < 0.05$.

A statistically significant increase was observed between the distances traveled in the 6MTW (Fig. 6). The mean of the group at the baseline test is 464 m (SD 128.56). The average in the test carried out after 2 weeks of stay was 532m (SD 127.63). The mean distance of the group after 4 weeks of rehabilitation is 551 m (SD 126.17). The distance after the end of rehabilitation was 579 m (SD 138.45). According to the authors, the reason for the increase in distances was the increasing adaptation to physical exertion.



1-distance of the initial test, 2-distance after 2 weeks of stay, 3- distance after 4 weeks of stay, 4- final test

Fig.6. Comparison of the lengths of 6MTW distances performed every 2 weeks, ANOVA for dependent groups, significance level $p < 0.05$.

Conclusions:

1. The authors' own research showed a statistically significant increase in the PEF parameter.
2. The 6MTW distance was extended after the comprehensive POST-COVID rehabilitation was carried out.
3. Patients suffering from COVID-19 disease who undergo comprehensive 6-week rehabilitation at the POST-COVID ward in Popielówek, improve their exercise capacity.
4. The 6MTW test, the PEF, and FEV1 ratio are useful in the initial assessment and control of the course of rehabilitation.

Discussion:

Peak expiratory flow (PEF) is the highest speed (l / min or l / sec) of airflow through the airways during a forceful exhalation preceded by a full inhalation. [3] PEF was assessed during spirometry. He is dependent on, among others the strength of the expiratory muscles. Comparing PEF before and after rehabilitation facilitated the assessment of the beneficial effect on strengthening the expiratory muscles.

Most of the available data in the literature concerns the beneficial effects of physical rehabilitation on PEF in patients with COPD or bronchial asthma. No application has been found in the literature for the course of rehabilitation monitoring after COVID-19 infection [4-9].

6MTW test - corridor test, used to assess the tolerance of effort and qualify the patient for the appropriate exercise group. It is used in people with a pulmonary and cardiological burden [10].

According to the authors, performed every two weeks, it allowed monitoring of the patient's progress in the ward, not only in terms of efficiency, which resulted in either staying in the assigned rehabilitation model or changing it. After a 2-week rehabilitation program, the 6MTW test increased the distance by 68 m. The group's distance after 4 weeks of stay in the ward was greater by 19 m. The difference in distance after 4 weeks to the final distance was 28 m more. The results of the 6MTW test also translate into the PEF parameter of the spirometric test. Initially, it was 5.21, and in the final study, the difference increased by 0.47. The control also tended to stabilize with oxygen saturation of blood, heart rate, and blood pressure.

Breathing exercises in the ward were performed mainly in a sitting and standing position due to the better work of the thoracic and abdominal respiratory tract [11]. During the exercises, the patients were supposed to breathe through the abdominal and thoracic tracks, because the activity ultimately led to the strengthening of the external and internal intercostal muscles, the diaphragm, and teaching the patient to breathe through the lower coastal track. Every movement of the patient was linked to the exhalation. In Urbański's research, the greatest work of the abdominal track was observed in standing position, smaller in sitting, and the lowest in lying down. In women, the participation of the abdominal track is comparable in every position. In men, diaphragm involvement is highest in the sitting position [11]. Breathing exercises are an integral part of the rehabilitation of patients with COPD or bronchial asthma because they deliver air to the lungs, develop strength along with the endurance of the respiratory muscles, and increase the mobility of the chest. Another important aspect is the proper flow of air through the lungs, which has a significant impact on the removal of bronchial secretions and the maintenance of airway patency [12].

Regular and consistent physical activity can make beneficial changes to the respiratory system. The activity has an effect on the respiratory rhythm and the progression of the ventilation-perfusion ratio, enhancing the strength of the respiratory muscles. This mainly improves the mobility of the chest. The results of the research show that the dysfunction of the intercostal muscles involved in the expiratory phase is a consequence of the decrease in the diameter of the fibers of these muscles as a result of decreasing physical activity, caused by the patient's neglect [13].

Reduced physical activity leads to chronic shortness of breath and fatigue. [14]. The developing dysfunction of peripheral muscles leads to the reduction of the patient's activity in everyday life. Individual respiratory physiotherapy plays a key role [15].

The initial stage of rehabilitation after COVID-19 infection is relatively difficult for the patient. The gradual increase in the load and physical activity allows not only to improve the patient's exercise tolerance but also to develop the habit of adopting the activity in everyday life [16].

Our own research shows that comprehensive rehabilitation with the use of endurance training has a positive effect on the improvement of exercise tolerance in patients with a history of COVID-19 disease [17].

As a result of physical rehabilitation, an improvement in the functional state of the respiratory system of the examined people was found, which is expressed by a significant increase in PEF indexes and an extension of the 6MTW distance.

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