THE RESULTS OF POST-COVID REHABILITATION IN PULMONARY CARE PATIENTS

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ABSTRACT

Post-Covid rehabilitation deals with properly selected exercises for the respiratory muscles, respiratory rehabilitation, learning to relax, and exercise. The aim of the study was to evaluate the results of post-Covid rehabilitation in pulmonary care patients. The study was performed on a group of 50 patients (15 women, 35 men; the mean age was 59.4 years) undergoing pulmonary rehabilitation in January 2022 in the rehabilitation department of a pulmonary hospital in southern Poland. Patients' physical activity tolerance was assessed before and after rehabilitation using the walk test, mMRC test, Barthel's scale, CAT questionnaire and Borg's scale. The research results show a statistically significant improvement in all patients and in each of the methods for assessing physical activity tolerance. There is an urgent need for a rehabilitation programme aimed specifically at post-Covid patients.

KEY WORDS: *Covid-19, rehabilitation, walk test, physical activity tolerance.*

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Introduction

The course of SARS-CoV-2 infection in humans is very individual (Wiersinga *et al.*, 2020; Chen *et al.*, 2020). Some patients will be asymptomatic, while others will have flu-like symptoms (Rodriguez-Morales *et al.*, 2020). Some people were hospitalised in a serious condition with acute respiratory failure (acute respiratory distress syndrome, ARDS). The main symptoms of SARS-CoV-2 coronavirus infection were: fever, a runny nose, a cough, muscle aches and fatigue (Murthy *et al.*, 2020). The reported symptoms also included conjunctivitis. In most cases, more than one symptom was observed. A distinctive feature was the loss of smell and taste, although not for every variant of the coronavirus. At the time of writing this, there were already a few mutations (Chadha *et al.*, 2021). Each had different dominant symptoms. Therefore, there is a possibility of reinfection, which can also be of varying severity.

The common denominator of all varieties in severe cases was total lung involvement, which led to cardiopulmonary failure. The progression of the development of circulatory and respiratory failure was associated with an increase in the level of pro-inflammatory cytokines. These patients frequently developed interstitial pneumonia leading to pulmonary fibrosis. In part of the population, this form of infection was fatal (Varga *et al.*, 2020; Guzik *et al.*, 2020).

After contracting Covid-19, patients struggle not only with a general weakness of the body. The main problem is the emergence of dyspnea after exercise, and often after daily home activities. In addition to health complications, there are mental and emotional problems. Often, after long stays in hospital, anxiety appears, a fear of what has happened. In some cases, depression appears. Patients have also reported problems with memory, and with regaining the lost senses of smell and taste. Some articles have described hair loss as a complication of infection. Interstitial pulmonary fibrosis and blood vessel dysfunction turned out

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to be the most dangerous complications after contracting Covid-19 (Rodriguez-Morales *et al.*, 2020; Halpin *et al.*, 2021). Given the specificity of the complications in patients, i.e. different clinical outcomes, such as coagulation disorders, myocarditis, insufficiency of various internal organs (lungs, kidneys), excessive immunological response, i.e. cytokine storm, and, of course, respiratory failure, the scope and type of rehabilitation exercises should be as personalised as possible, and at the same time maximally accessible to potential participants. Physical dysfunction includes mood swings, fatigue, and even post-traumatic stress disorder (PTSD), resulting from the avoidance of an immediate threat to life, the severity of the disease, and a long isolated stay in intensive care. Therefore, in rehabilitation activities, specialist psychological and psychiatric help should not be omitted if necessary. The situation is all the more difficult as there is no single catalogued pattern indicating the severity of the course of Covid-19, and long-term post-Covid complications may also apply to asymptomatic or oligosymptomatic patients (Wade, 2020; Księska-Koszałka, 2021).

The severe course of SARS-CoV-2 virus infection is often associated with the presence of comorbidities. People with cardiovascular disease, diabetes, obesity, respiratory disease, hypertension or cancer are particularly vulnerable. The research indicates that people with impaired immunity have a greater predisposition to severe complications than the healthy population (Beeching *et al.*, 2022; Lew *et al.*, 2020; Meijs *et al.*, 2022).

The article by Spannbauer *et al.* devoted to in-patient rehabilitation of Covid-19 patients in the light of the author's own experience points to the importance of rehabilitation in intubated patients staying in the intensive care unit, where passive exercise is important in the context of maintaining joint mobility, preventing contractures, improving venous flow, preventing joint stiffness, and supporting the mobility of the chest. The authors' experience shows that after only a few days of intubation and forced immobilisation in the supine position, patients experience significant muscle weakness. This stage is therefore crucial for the pace of convalescence and the patient's functioning later, and is of prophylactic importance. Exercises in extubated patients are more dynamic, related to the improvement of respiratory efficiency, bronchodilation, learning the breathing path and effective coughing. However, before the patient becomes involved in this active part of rehabilitation, it is necessary to overcome difficulties associated with the gradual upright standing of the patient, increasing dyspnea, saturation drops and extreme fatigue. The exhaustion initially felt, however, should gradually wear off, and the patient can, and also should, try to carry out the usual daily activities on his/her own, such as eating, brushing and toileting (Spannbauer *et al.*, 2021).

The statement by the Polish Respiratory Society and the Polish Society of Allergology on the treatment of pulmonary complications in patients after SARS-CoV-2 infection is a document presenting 32 recommendations for physicians on the treatment of pulmonary complications in patients with Covid-19. Among the recommendations by this body, we also have recommendations for rehabilitation. The time for rehabilitation is therefore determined by determining the period when the patient becomes non-infectious and after excluding contraindications. It is also pointed out that the earlier the rehabilitation intervention is started and the longer it lasts, the sooner the patients have a chance to recover. It is emphasised that the period of six to eight weeks after the onset of Covid-19 is of particular importance, when the patient should gradually return to his/her pre-disease activity, and at the same time increase physical activity, adapting it to his/her abilities. Obviously, patients with comorbidities should be monitored for shorter periods (four to six weeks after hospitalisation), unless there are indications for an earlier consultation. The position of the societies is also to recommend a formal assessment of the patient's ability to function six to eight weeks after hospitalisation, in order to guide further treatment and rehabilitation. It is recommended to perform 6MWT at the beginning and the end of rehabilitation, taking into account the assessment of the patient's saturation during exercise. The recommendations also include treatment regimens in various groups of patients, the management of children, the issue of vaccinations for convalescents, and the monitoring of complications from the disease (Piotrowski *et al.*, 2021).

A literature review on the effectiveness of the rehabilitation of post-Covid patients by Wen *et al.* allowed for the conclusion that rehabilitation in these patients brings a visible improvement. Based on an analysis of 40 works devoted to this topic, the authors indicate that rehabilitation should begin during the patient's stay in hospital, concurrently with other procedures, and should then be continued after discharge on an out-patient basis or at the patient's home, stationary or remotely. That is why the educational part of the rehabilitation is also so important, in the form of learning self-care and behaviours that have a preventive meaning for droplet-borne diseases (Wen *et al.*, 2022).

Methods of assessing exercise tolerance in patients after Covid-19

Interventions dedicated to post-Covid-19 patients are not fundamentally different from those recommended for other cardio-pulmonary patients; however, a thorough assessment of patients' clinical condition helps to refer them to pulmonary and rehabilitation care units. We should also note that some patients were not diagnosed with Covid-19 officially (with a referral and reverse transcription polimerase chain reaction [RT-PCR] testing), being sick at home, but also in them the consequences of the disease manifesting itself after its history may require physiotherapeutic treatment at some stage (Rodriguez-Morales *et al.*, 2020; Santana *et al.*, 2021). We should also remember that patients' recovery after Covid-19 is also a phenomenon that influences the rehabilitation results. That is why an interview with the patient prior to the rehabilitation programme has to include questions concerning the onset of symptoms, whether the patient was hospitalised for Covid-19, whether the patient was admitted to the intensive care unit, whether the patient was diagnosed with pneumonia, what treatment was included, whether ventilation was included and for how long, what comorbidities were found that may influence the course of the disease and the rehabilitation, and whether the patient noted changes in everyday functioning, such as fatigue, breathing difficulties, sleep changes, cognitive changes, and so on. Recommendations for physiotherapy in adult patients diagnosed with Covid-19 in Poland are based on the recommendations of the Polish Chamber of Physiotherapists, and were developed in 2020. They include safety issues and breathing techniques, the improvement of general fitness, and the rehabilitation of ventilated patients (Recommendations, 2022).

Physiotherapy in pulmonology is a complex approach to the patients' respiratory limitations. This includes increasing breathing comfort and reducing the symptoms associated with lung disease in general, such as shortness of breath, coughing and fatigue. We also try to overcome the patient's difficulties relating to the insufficient ventilation of previously infected areas of the lungs, if possible. This often comes with learning to adopt the correct body posture and the proper breathing pattern, and with strengthening the respiratory and other muscles. All these actions are aimed at increasing exercise tolerance and lowering the respiratory work. Thanks to physiotherapy, the patient breathes more freely and deeply, tolerates exercise better, sleeps better, and feels less tired. Methods of pulmonary rehabilitation include breathing exercises, bronchial postural drainage, and effective cough techniques (Spruit *et al.*, 2020; Tleyjeh *et al.*, 2022).

The main complication of SARS CoV-2 infection is dyspnoea, which is the primary symptom of exercise intolerance (Halpin *et al.*, 2021). That is why the most important aim of post-Covid patients is to improve the body's efficiency, by increasing properly selected physical activity. The appropriate intensity of exercise is selected taking into account the physical abilities of the patient. Physical activity should be preceded by an exercise tolerance test. With its help, we can determine the initial level of physical fitness, which will allow short-term and long-term goals to be defined, and to plan a training programme. When performing an exercise test, it should be considered whether the patient requires further oxygen therapy (Tleyjeh *et al.*, 2022).

There are certain rules that must be followed in order to perform an exercise test safely. The examiner should be trained in cardio-pulmonary resuscitation, and the room should be equipped with oxygen and an emergency kit. Typically, during the test, maximum loads and a variety of scales and tools are used (Mancini *et al.*, 2021; Barman *et al.*, 2022). The patient determines dyspnea and fatigue himself, so it is a subjective assessment. Two exercise tests are used most often among post-Covid patients: exercise tests with maximum, increasing load, and walking tests, the results of which are the main tool analysed in this study.

The aim of the study

The aim of the study was to evaluate the results of post-Covid rehabilitation in pulmonary care patients. Specific objectives were concerned with the differences that may be observed in patients examined by 6MWT, Borg scale, CAT questionnaire, Barthel scale, mMRC scale and a comparison of dependencies between these methods of evaluation.

1. Materials and methods

The study was performed on a group of 50 patients (15 women, 35 men; mean age 59.4 years) undergoing pulmonary rehabilitation in January 2022 in the rehabilitation department of a pulmonary care hospital in southern Poland. Rehabilitation was undertaken approximately two weeks after the infection had ceased, on the recommendation of the referring physician. The research was approved by the Bioethics Committee of the Cracow School of Health Promotion. The main characteristics of the study group are presented in Table 1 below.

Table 1. Characteristics of the study group

	Mean	**Median**	**Minimum**	**Maximum**	**SD**
Age	59.4	60.0	29.0	81.0	12.1
Height (in cm)	172.5	172.5	157.0	189.0	7.7
Weight (in kg)	85.6	85.0	53.0	133.0	13.6
BMI	28.7	28.2	21.2	38.0	3.6

Comorbidities were present in 31 out of 50 patients (62%), and these were mainly obesity, hypertension, diabetes mellitus, and other previous breathing difficulties.

Patients' physical activity tolerance was assessed before and after the rehabilitation programme using the walk test, mMRC test, Barthel's scale, CAT questionnaire and Borg's scale.

The six-minute walk test is used to assess exercise tolerance in patients after SARS CoV-2 infection and other respiratory problems. It is most often used in pulmonology in patients with COPD. Before the test, the patient is advised to rest for ten minutes. Before, during and after the walk, the oxygen saturation (SpO2) level and the patient's pulse rate are monitored with a pulse oximeter. The test is performed in a hallway. During the test, the patient should move as fast as possible, but must not run during the test. The patient has the ability to stop and take a break if shortness of breath or fatigue arises. The test lasts six minutes, and during this time the physiotherapist determines the path that the patient takes in order to calculate the energy expenditure, which is expressed in metabolic equivalent (MET). Before and after the examination, the patient fills in the Borg scale, which determines the intensity of dyspnea and fatigue, and the physiotherapist, apart from measuring with a pulse oximeter, also tests the blood pressure. If the patient reports chest pain, increasing dyspnoea and fatigue during the test, or a decrease in saturation below 85%, the test should be stopped immediately (Laboratories ATS, 2002). Based on European Respiratory Society guidelines and a systematic review of patients with cardio-pulmonary disease, we predefined that an improvement of 30.5 m would be the minimal clinically important difference (MCID) (Bohannon, Crouch, 2017). We also followed detailed Polish Respiratory Society guidelines on the use of 6MWT (Przybyłowski *et al.*, 2021).

The modified Borg scale, which assesses the intensity and severity of breathlessness, is used in monitoring the progress and mode of exercise in cardiac patients, as well as in other patient populations undergoing rehabilitation and endurance training. The Borg RPE scale was developed by Gunnar Borg for rating exertion and breathlessness during physical activity, that is, how hard the activity is, as shown by high heart and respiration rate, profuse perspiration and muscle exertion (Borg, 1998). In patients after Covid-19, the Borg scale allows the degree of fatigue to be assessed with the 6MWT test (Nopp *et al.*, 2022).

The CAT questionnaire (COPD Assessment Test questionnaire) is a patient-completed questionnaire assessing globally the impact of COPD (cough, sputum, dyspnoea, chest tightness) on health status (Jones *et al.*, 2009). The questionnaire consists of eight questions, concerning the cough, phlegm presence, chest tightness, shortness of breath, limitations in everyday activities, confidence in leaving home, sleeping, and energy of a patient. Higher scores denote the more severe impact of COPD on a patient's life. The difference between stable and exacerbation patients was five units.

The *mMRC scale (modified Medical Research Council scale)* is a tool for assessing the impact of dyspnea on a patient's daily life (Bestall *et al.*, 1999; Stenton, 2008). The patient assesses the occurrence of the degree of dyspnea depending on the activity in the last seven days, thus assessing his/her inability or limitations in performing daily activities (Rajala *et al.*, 2017). It is a five-point scale, with scores ranging from 0 to 4. The patient is asked to evaluate breathlessness from 0 ('I only get *breathless with strenuous exercise'), to 4 ('I am too breathless to leave the house'* or '*I am breathless when dressing') (*Crisafulli, Clini, 2010*).*

The *Barthel scale* is used to assess a patient's dependence on the help of other people in carrying out various daily activities. The activities evaluated include meals, getting dressed, sitting and standing up, being hygienic, moving around, climbing stairs, and sphincter control. The summarised results of the patient are described as: I) 85 to 100 points, mild dependency of a patient; II) 21 to 85 points, moderate dependency; III) 0 to 20 points, severe dependency. First described in 1965 (Mahoney, Barthel 1965), the Barthel index has been successfully used to assess daily activities in patients with different cardio-pulmonary problems, old age patients, and post-Covid patients (Trevissón-Redondo *et al.*, 2021).

Statistical analysis

To assess the selected values before and after rehabilitation, the pair test was used, either the t-Student test or the Wilcoxon test. To assess the relationship between the results of the walk test and the selected variables, the Persons' correlation coefficient was calculated. A significance level of $p < 0.05$ was adopted in all the tests performed. The calculations were made with the use of SPSS software for Windows v. 22.0 (IBM Corp. Released 2013. IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp.).

2. Results

Table 2 summarises the general results of measures taken before and after rehabilitation. The results obtained were further compared using the pair test, searching for statistical significance.

Table 2. The general results of measures taken before (I) and after (II) rehabilitation (n = 50)

	Mean	**Median**	**Minimum**	**Maximum**	**SD**
6MWT I	310.3	340.0	0.0	580.0	166.8
6MWT II	491.1	500.0	0.0	720.0	135.3
CAT I	17.9	17.5	4.0	34.0	6.2
CAT II	12.4	12.0	2.0	24.0	5.7
mMRC I	2.7	3.0	1.0	5.0	0.8
mMRC II	1.6	2.0	1.0	4.0	0.7
Borg scale I	15.3	15.0	11.0	20.0	3.1
Borg scale II	12.1	11.0	6.0	18.0	3.2
Barthel Index I	91.6	95.0	30.0	100.0	11.6
Barthel Index II	95.9	100.0	10.0	100.0	13.7

Table 3 shows the results of the walk test obtained before and after rehabilitation. The student t-test was used for paired samples. The mean distance obtained increased after rehabilitation by 180.8 m, and this result was statistically significant.

Table 3. The result of the 6MWT assessed before and after rehabilitation (t-student test for dependent samples)

	Mean	**SD**	**Difference**	**t**	**p**
Before	310.3	166.8			
After	491.1	135.3	-180.8	-8.8520	< 0.0001

Table 4 presents the results of the Borg scale obtained before and after rehabilitation. The statistically significant mean result after rehabilitation was lower by 3.3 points.

Table 4. Borg scores assessed before and after rehabilitation (t-student test for dependent samples)

	Mean	**SD**	**Difference**	**t**	**p**
Before	15.3	3.1			
After	12.1	3.2	3.3	12.6149	< 0.0001

Table 5 shows the results of the CAT scale obtained before and after rehabilitation. The statistically significant results show a decrease in the score by 5.5 points after rehabilitation.

Table 5. CAT questionnaire results assessed before and after rehabilitation (t-student test for dependent samples)

	Mean	**SD**	**Difference**	**t**	**p**
Before	17.9	6.2			
After	12.4	5.7	5.5	8.5330	< 0.0001

Table 6 presents the results of the mMRC scale obtained before and after rehabilitation. On the basis of the performed test, a significant difference was found in the mMRC test before and after rehabilitation. The level of perceived breathlessness in patients was significantly reduced, and the average difference was 1.0 point.

Table 6. mMRC scores assessed before and after rehabilitation (Wilcoxon pair test)

	Mean	**SD**	**Difference**	**Z**	**p**
Before	2.7	0.8			
After	1.6	0.7	1.0	5.3028	< 0.0001

Table 7 shows the results of the Barthel scale obtained before and after rehabilitation. On the basis of the performed test, a significant difference was found in the measurement of the Barthel scale before and after rehabilitation. The measurement result increased significantly, showing less dependency, and the average difference was 4.3 points.

Table 7. Barthel Index scores assessed before and after rehabilitation (Wilcoxon pair test)

	Mean	**SD**	**Difference**	**Z**	**p**
Before	91.6	11.6			
After	95.9	13.7	-4.3	3.9850	0.0001

The relationship between the walk test and selected variables

The relationship between the result of the walk test and selected variables before and after rehabilitation was also examined. Pearson's linear correlation coefficient was used.

Table 8 presents the results of the dependence of the walk test between age, the CAT questionnaire results, and the mMRC scale after rehabilitation. Pearson's linear correlation coefficient was used.

Table 8. The results of the dependence of the walk test between age, CAT, mMRC (Pearson's linear correlation coefficient)

Before rehabilitation	Age	CAT	mMRC
6MWT	-0.356	-0.548	-0.640
	p = 0.011	p < 0.001	p < 0.001
After rehabilitation	Age	CAT	mMRC
6MWT	-0.524	-0.347	-0.554
	p < 0.001	p = 0.014	p < 0.001

The results of the comparison show that the age, CAT questionnaire results and mMRC scale results were statistically significant in influencing the results of the 6MWT distance obtained. Elderly patients with a more severe impact of dyspnea had statistically significantly lower results in 6MWT both before and after rehabilitation.

We also tested for 6MWT results and the influence of other variables, such as BMI, weight, Borg scale and Barthel Index, but these results proved insignificant.

The relationship between the walk test and the presence of comorbidities

Table 9 shows the results of the relationship between the walk test and the occurrence of comorbidities before and after rehabilitation. On the basis of the performed test, a significant difference was found in the results of the walk test, depending on the presence of comorbidities. People with comorbidities had significantly lower results in the walk test. Comorbidities had no effect on the result of the walk test before rehabilitation.

Table 9. The results of the relationship between the 6MWT results and the coexistence of diseases (t-student test for independent samples)

Before rehabilitation: comorbidities and 6MWT	Mean	SD	t	p
Yes	284.7	173.9		
No	352.1	149.5	-1.4013	0.1676
After rehabilitation	Mean	SD	t	p
Yes	460.3	147.7		
No	541.3	95.9	-2.1272	0.0386

3. Discussion

The need for rehabilitation during and after the Covid-19 pandemic has been noted by many authors (Gutenbrunner *et al.*, 2020; Agostini *et al.*, 2021; Barman *et al.*, 2022; Ceravolo *et al.*, 2020; Halpin *et al.*, 2021).

The results of our research clearly indicate an improvement in the physical activity tolerance of respondents after undergoing a post-Covid rehabilitation programme. There was a statistically significant improve-

ment in all patients and in each of the methods for assessing respiratory efficiency. The distance covered in 6MWT after rehabilitation increased by an average of 180.8 m ($p< 0,0001$), showing patients' greater ability of physical activity tolerance. This observation was confirmed by the result of the Borg scale measurement that decreased significantly, and the average difference was 3.3 points ($p< 0,0001$), indicating lower exertion in patients during activity. The result of the CAT test after rehabilitation decreased by an average of 5.5 points ($p< 0,0001$), and our patients' everyday activities were less aggravating. The mMRC level of dyspnea also decreased by an average of 1.0 point ($p< 0,0001$), showing that patients suffered less breathlessness. Also, the result of the measurement using the Barthel scale increased significantly, and the mean difference was 4.3 points ($p = 0,0001$), confirming the improvement of patients' conditions in everyday functioning. The age and the presence of comorbidities were significant factors influencing the outcome of post-Covid rehabilitation in the walking test. Elderly and comorbid patients also benefited from rehabilitation, but to a lesser extent than younger and unburdened patients. We have to stress that comorbidities had no effect on the result of the walk test before rehabilitation, and that shows the overall serious condition of all patients at the beginning of the rehabilitation programme.

Measuring patients' physical activity tolerance, exertion and breathlessness is often an important sign of the overall cardio-pulmonary and physical exercise capacity. Many authors show similar results achieved with the use of the same methods of physical activity tolerance in post-Covid patients. The Cochrane Rehabilitation 2020 Report (Ceravolo *et al.*, 2020) summarising different papers on the topic, has already noted that after discharge, Covid-19 survivors may report persistent restrictive ventilatory deficit, regardless of the disease severity, and a substantial increase in resources (staff and equipment) is needed for rehabilitation. This was later confirmed by other authors, indicating that in patients who have recovered from Covid-19, the physical and functional impairment can persist for weeks after hospital discharge, as can some symptoms (such as dyspnea, desaturation, coughing, weakness and fatigue). In addition to the damage caused by prolonged hospitalisation and inactivity, the persistent high inflammatory burden and previous health conditions seem to have a negative influence on the recovery of these patients (Santana *et al.*, 2021; Spruit *et al.*, 2020; DeLorenzo *et al.*, 2020; Negrini *et al.*, 2020). The problem is also that in Poland, the post-Covid rehabilitation system is very diverse, and its financing and organisation are handled by the National Health Fund (NFZ), the Social Insurance Institution (ZUS), the Agricultural Health Insurance Fund (KRUS), the State Fund for the Rehabilitation of Disabled Persons (PFRON), and local governments. The goals and tasks of these institutions are in many cases divergent, which results in the lack of a clearly defined path that can be followed by a patient struggling to improve health and return to work ability. Hence patients often rely on a referral from the attending physician, who indicates what form of rehabilitation should be undertaken and when. It is recommended by the Statement of the Polish Respiratory Society and the Polish Society of Allergology on the treatment of pulmonary complications in patients after SARS-CoV-2 infection to perform 6MWT at the beginning and the end of rehabilitation, taking into account the assessment of the patient's saturation during exercise (Piotrowski *et al.*, 2021). Concerning the results of 6MWT, a study performed by Hermann *et al.* (2020) also used this test of exercise capacity at hospital admission and discharge within 20 days of a patients' stay. Researchers observed that the functional capacity and the subjective health status of patients improved significantly, as assessed by 6MWT (on average +130 m) for the evaluated cohort. Our result of +180 m is also a significant improvement; however, we did not distinguish the study group for previous ventilation. The same result of +180 m in 6MWT was also observed by Spielmanns *et al.* (2021) in a study on a group of 99 pulmonary rehabilitation post-Covid patients. A study by Nopp *et al.* on a group of 58 patients also shows an improvement in 6MWT results; however, on average the distance walked was longer by 62.9 m. The authors also followed European Respiratory Society guidelines (Nopp *et al.*, 2022).

Measuring breathlessness in post-Covid patients is difficult, as the measure is a subjective feeling. There are comments on the validation of the mBorg method in order to achieve the most reliable results possible (Johnson *et al.*, 2016). However, the results of our study show that after rehabilitation, the Borg scale score was significantly lower, thus authorising us to say that the 6MWT test performed after rehabilitation was noticeably less strenuous for the participating patients.

A study by Daynes *et al.* (2021) proved that using the CAT questionnaire in patients recovering from Covid-19 in order to assess symptom-based needs for rehabilitation is reasonable and purposeful. What is more, the results demonstrated a high CAT total score for patients following an admission of Covid-19, especially regarding breathlessness, activity limitation, the confidence to leave home, sleep and energy, even in patients with no previously diagnosed lung disease. A similar observation concerned our study, where before rehabilitation the mean results for our patients were significantly higher, thus indicating the severe impact of Covid-19 on patients' everyday life. That is why quantifying the impact of respiratory dysfunction symptoms on patients' overall health seems justified, as is confirmed by the results of our study. The overall health and quality of life of a patient may be noticeably influenced by Covid-19. The results of the HRQoL study by Santus *et al.* (2020) showed that 15 days after discharge from a hospital the mean mMRC score decreased significantly ($p=0.031$), and 30% of patients achieved a clinically important change of ≥1 point. The mean (SD) Borg score increased from 12.8 (4.2) to 14.3 (2.4); $p<0.01$. The treatment itself of course has a beneficial effect; however, the authors stress the need for an assessment of how much breathlessness impacts a patient's functioning and HRQoL, which may help in designing a further appropriate rehabilitation programme. Similar perceptions were made by Halpin *et al.* (2021).

Research performed on a group of 68 patients by Trevissón-Redondo *et al.* (2021) shows that a comparison of the functional assessment of patients by the Barthel Index before Covid-19 and after the disease indicates significantly lower results, and thus increased dependency of post-Covid patients (mean scores 83.20 and 52.30 respectively, $p<0,001$). In our research, patients before rehabilitation received considerably higher scores, which showed their initially better health status; however, improvement after rehabilitation was clear and statistically significant, showing 95 points. Also, spectacular improvement was noted in a study by Zampogna *et al.*, where the Barthel Index score for 140 patients enrolled in rehabilitation improved from 55.0 (30.0– 90.0) before the programme to an average of 95.0 (65.0–100.0) ($p = 0.00$) after the programme (Zampogna *et al.*, 2021).

This limited study (performed on a group of only 50 patients) has only been a small observational study, while more detailed research is also needed. Covid-19 has increased our awareness of airborne-transmitted infectious diseases. The in-patient and out-patient care patterns may change; however, many actions are aimed at the prevention of the disease. Some patients will recover rather quickly without any specific rehabilitation or physiotherapy programmes, while in some patients so-called 'long-covid' symptoms may be visible for months, and some symptoms, such as pulmonary fibrosis, may be permanent. Nevertheless, rehabilitation in these patients is recommended, regardless of age and comorbidities, because it may significantly improve the patients' quality of life, reduce the burden of the disease's consequences, and act preventively in the future.

Despite the rapid spread of vaccination against Covid-19, the numbers of infections and deaths remain high in many regions. The epidemic's pressure on health systems is related to the rearrangement of treatment and support activities in every field of medicine, including rehabilitation. The significant influx of patients, especially the seriously ill, is an organisational challenge, especially in intensive care. These patients, often with comorbidities, are particularly prone to the severe course of Covid-19, and their subsequent rehabilitation will certainly be longer and more multifaceted than in uncomplicated patients. There are also some notions concerning the population knowledge on prophylaxis, where attention is focused on the knowledge of the course of the disease, the need to consult a doctor early, the monitoring of saturation and paying attention to the feeling of dyspnea, as well as compliance with medical recommendations regarding both treatment and convalescence.

Conclusions

Summing up the results of our study, it can be clearly seen that a rehabilitation programme following the Covid-19 disease may lead to a significant improvement in the overall health status of patients, their physical activity tolerance, and cardio-respiratory capacity. Rehabilitation following the Covid-19 disease brings a

significant improvement in patient respiratory capacity and general fitness, as is assessed by the 6MWT walk test. This improvement is visible in all patients, even in old age and with comorbidities. That is why there is an urgent need for extensive rehabilitation aimed specifically at Covid-19 patients.

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PACIENTŲ, PERSIGUSIŲ PLAUČIŲ LIGOMIS, REABILITACIJOS PO COVID-19 PANDEMIJOS REZULTATAI

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Santrauka

Šalinant COVID-19 ligos pasekmes būtinas fizioterapinis gydymas, ypač kvėpavimo, širdies ir kraujagyslių sistemos. Reabilitaciją po koronaviruso apima: tinkamas kvėpavimo raumenų pratimų parinkimas, kvėpavimo reabilitacija, mokymasis atsipalaiduoti ir mankštintis. Kruopščiai tiriami fizinio aktyvumo tolerancija ir krūvis, siekiant įvertinti bendros sveikatos būklės pagerėjimą prieš ir po gydymo. Tyrimo tikslas – įvertinti reabilitacijos įtaką sergančiųjų COVID-19 liga fizinio aktyvumo tolerancijai.

Metodai. Tyrimas atliktas su 50-ies pacientų grupe (15 moterų, 35 vyrai; amžiaus vidurkis – 59,4 metų), kuriems 2022 m. sausio mėnesį Lenkijos plaučių ligoninės reabilitacijos skyriuje atlikta plaučių reabilitacija. Pacientų fizinio aktyvumo tolerancija įvertinta prieš ir po reabilitacijos naudojant vaikščiojimo testą, Barthel'io skalę, CAT klausimyną ir Borg'o skalę. Norint įvertinti ėjimo testo rezultatų ir pasirinktų kintamųjų tarpusavio ryšį, apskaičiuotas koreliacijos koeficientas. Visuose atliktuose tyrimuose priimtas reikšmingumo lygis p <0,05.

Rezultatai. Tyrimo rezultatai atskleidė, kad po reabilitacijos pagerėjo respondentų fizinio aktyvumo tolerancija. Statistiškai reikšmingai pagerėjo visų pacientų fizinė būklė ir kiekvienas fizinio aktyvumo tolerancijos vertinimo rodiklis, vertinant atskirai. Ėjimo testo rezultatas po reabilitacijos padidėjo vidutiniškai 180,8 m (p <0,0001). Borgo skalės matavimo rezultatas ženkliai sumažėjo, vidutinis skirtumas – 3,3 balo

(*p* <0,0001). CAT tyrimo rezultatas po reabilitacijos sumažėjo vidutiniškai 5,5 balo (*p* <0,0001). Dusulio lygis sumažėjo vidutiniškai 1,0 balo (*p* <0,0001). Matavimo pagal Barthel'io skalę rezultatas reikšmingai padidėjo, vidutinis skirtumas – 4,3 balo (*p* <0,0001). Amžius ir gretutinių ligų buvimas buvo reikšmingi veiksniai, turintys įtakos reabilitacijos po koronaviruso rezultatams atliekant ėjimo testą.

Taigi reabilitacija po COVID-19 ligos pagerina paciento fizinio aktyvumo toleranciją, įvertintą vaikščiojimo testu. Pagerėjimas buvo akivaizdus visiems, net vyresnio amžiaus ir gretutinių ligų turintiems pacientams. Akivaizdu, kad COVID-19 sirgusiems pacientams reabilitacija būtina.

PAGRINDINIAI ŽODŽIAI: *COVID-19, reabilitacija, vaikščiojimo testas, fizinio aktyvumo tolerancija.*

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