ORIGINAL ARTICLE

SUPERVISED PHYSICAL TRAINING AFTER HOSPITALIZATION FOR COVID-19: AN EXPERIMENTAL STUDY

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Highlights: (1) Improvement in functionality after physical training in those affected by COVID-19; (2) Increase in respiratory muscle strength due to training after COVID-19; (3) Change in quality of life after physical training in those affected by COVID-19.

PRE-PROOF
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SUPERVISED PHYSICAL TRAINING AFTER HOSPITALIZATION FOR COVID-19: AN EXPERIMENTAL STUDY

ABSTRACT

Objective: To verify the effects of supervised physical training after hospitalization for COVID-19. **Methods**: Quasi-experimental study with 17 patients referred to the physiotherapy outpatient clinic of a public hospital in Goiânia, Goiás, Brazil after hospitalization for COVID-19. They were evaluated before and after 18 sessions of supervised physical training. A form with sociodemographic and economic data, six-minute walk test, one-minute sit-to-stand test, manovacuometry, Modified Medical Research Council, London Chest Activity of Daily, post-COVID-19 functional status scale and the Short Form Health Survey were used. For continuous variables, mean, standard deviation or median with 25th and 75th percentiles were used. For categorical variables, frequencies were used. The distribution was tested by Shapiro Wilk. For comparison, the paired t-test and Wilcoxon tests were used. The significance level was 5%. **Results:** There was an increase in the distance walked (392.5 ± 105.9 vs 484.7 ± 95.4 m, p<0.001), in the number of repetitions in the sit-to-stand test (16.0 vs 21.5, p<0.001), in the maximum inspiratory pressure (100 vs 110, p=0.005) and in all domains of quality of life (p<0.001). Dyspnea reduced in the Modified Medical Research Council from grades two, three, four (10 patients) to zero and one (17 patients) and in the London Chest Activity of Daily from 25.8 ± 11.2 to 15.6 ± 4.5 points (p<0.001). **Conclusion**: Supervised physical training improved functional capacity and quality of life, in addition to reducing dyspnea during daily activities and increasing maximum inspiratory pressure.

Keywords: COVID-19; SARS-Cov-2; Physiotherapy; Physical Exercise; Rehabilitation Services

INTRODUCTION

The spread of COVID-19 from 2020 to 2022 resulted in approximately 690,000 fatalities in Brazil and approximately 6,644,643 worldwide (WHO, 2022). In survivors, especially those who had the severe form of the disease, symptoms persist that lead to motor, respiratory, and sometimes mental disabilities[1]. The most common persistent symptoms include fatigue, cough, dyspnea, chest pain, joint pain, and myalgia[2]. Functional impairment occurs mainly among those who were hospitalized for a prolonged period and had the severe form of the disease, but it can also be present in individuals who had the mild form.

The persistence of symptoms for more than four weeks after the acute phase indicates the presence of long-term effects of COVID-19, characterizing disabilities that directly interfere with the ability to exercise, perform daily activities, and quality of life[3-5]. The need for supervised physical training is evident, based on reducing symptoms, minimizing disabilities and improving functionality after the acute phase[6]. This type of treatment has shown improvements in exercise capacity, fatigue and cognition[7]. In terms of quality of life, the increase is 14% on average[8] after six weeks of supervised physical training. Other benefits such as improved functional capacity, decreased dyspnea on exertion and increased peripheral muscle strength were observed regardless of the severity of the disease.

Studies[7-8,10] indicate positive changes in the functional health of individuals who participated in rehabilitation programs after the acute phase of COVID-19, but further studies are necessary so that we are able to direct public health policies to establish coping and rehabilitation strategies, aimed at the demands and sequelae left by the disease.

In this context, the objective of this study was to verify the effects of supervised physical training on functional capacity, dyspnea in daily activities, respiratory muscle strength and quality of life after COVID-19.

MATERIALS AND METHODS

Quasi-experimental, before-and-after study conducted at a large public hospital in the capital Goiânia, in the state Goiás, Brazil. It was approved by the Research Ethics Committee of the Pontifical Catholic University of Goiás under opinion number 4,767,764 and by the Research Ethics Committee of the Hospital das Clínicas de Goiânia as a co-participating institution under opinion number 4,852,278, following the guidelines for research with human beings of Resolution 466/2012 of the National Health Council.

The convenience sample consisted of patients who were admitted to the Intensive Care Unit (ICU) and wards due to COVID-19 and, 28 days after discharge, referred for supervised physical training at the physiotherapy outpatient clinic of the aforementioned institution.

The study included individuals who tested positive for COVID-19 in an RT-PCR/antigen test and were referred to the rehabilitation service, of both sexes, over 18 years of age, and who were hospitalized in the ICU and in wards due to respiratory and motor complications caused by the disease. The study excluded individuals with decompensated cardiovascular disease, a history of acute myocardial infarction in the last three months, severe congestive heart failure, neurological/orthopedic diseases that prevented physical training, individuals with a history of chronic lung diseases with exacerbation in the last 3 months, and participants who were already receiving some form of respiratory and physical therapy concomitantly with the research protocol proposal.

A semi-structured form was used to characterize the sociodemographic, economic, and clinical profile. Functional capacity was assessed with the 1-minute sit-to-stand test (SST1min), which analyzed the physical fitness and muscle strength of the lower limbs (LL) of the participant through the number of repetitions performed[11]. The six-minute walk test (6MWT) was also used, following the recommendations of the American Thoracic Society (ATS)[12]. Heart rate (HR) and peripheral oxygen saturation (SpO2) were monitored during the tests. In addition, the participant was presented with the BORG scale for subjective analysis of dyspnea and muscle fatigue on a scale of zero to ten, where zero is the absence of dyspnea or perceived fatigue and ten is the maximum perception of these symptoms[13].

Functional limitations were assessed using the Post-COVID-19 Functional Status Scale (PCFS) for functional status after COVID-19. The classification ranged from zero to five, with 0 (no functional limitations) for those who had no symptoms of pain, depression or anxiety; 1 (very mild functional limitations) for those in whom tasks could be performed with the same intensity, but with some symptoms of pain, depression or anxiety; 2 (mild functional limitations) for those who had their daily or work tasks performed at a lower intensity or were occasionally avoided due to symptoms of pain, depression or anxiety; 3 (moderate functional limitations) for those who had their tasks at home or at work structurally modified due to symptoms of pain, depression or anxiety;

4 (very severe functional limitations) for those who required assistance in daily activities due to symptoms of pain, depression or anxiety; and 5 (death), an outcome not assessed in this sample[14]. Maximum inspiratory pressure (MIP) and maximum expiratory pressure (MEP) were assessed using a Murenas® analog manometer, previously calibrated in cmH20, with an operational limit of -300 to +300 cmH20.

Each measurement was performed three to five times, starting from residual volume (RV) to total lung capacity (TLC) and vice versa, with reproducibility when the difference between measurements was less than 10%. During the measurement, the participant was comfortably seated, with a nose clip and SpO2 and HR15 monitoring. The highest MIP and MEP were considered for data analysis purposes and the equations proposed for men were considered: (MIP: y = −1.24xidade + 232.37 (R2 = 60.73; epr = 356.58; epe = 18.88; 5th percentile = −23.38) MEP: y = −1.26xidade + 183.31 (R2 = 48.9; epr = 586.81; epe = 24.22; 5th percentile = −38.95) and for women: (MIP: y = −0.46xidade + 74.25 (R2 = 24.8; epr = 300.72; epe = 17.20; 5th percentile = −28.83); pemax: y= −0.68xity + 119.35 (R2= 35.14; epr= 315.33; epe= 17.76; 5th percentile= −23.24). R2 is considered as the coefficient of determination, epr as the residual standard error and epe as the standard error of the estimate[15].

Dyspnea during daily activities was assessed by the London Chest Activity of Daily Living (LCADL) which is grouped into domains such as personal care, physical activities, household activities and leisure. The score is given from zero to five and the total score up to 75 points. The higher the value, the worse the dyspnea during daily activities[16].

The Modified Medical Research Council (mMRC) scale also assesses dyspnea. Its modified version has scores ranging from zero to four where (0) represents dyspnea only when performed intense physical effort; (1) reported dyspnea when walking quickly on the flat or when climbing a small hill; (2) walked slower than other people of the same age due to dyspnea or the need to stop to rest; (3) needed to stop to breathe after walking about ninety meters on the flat and (4) could not leave the house due to shortness of breath or felt it when getting dressed[17].

Quality of life was assessed with the Short Form Health Survey (SF-36), a questionnaire composed of 36 items in eight domains: functional capacity, physical aspects, pain, vitality, social aspects, emotional aspects, mental health and general health status. Each item has its reference value, which is converted into grades to obtain the score. The score ranges from 0 to 100, with the higher the score, the better the quality of life.[18].

After the initial assessment, the participant completed eighteen supervised physical training sessions with strengthening, aerobic and flexibility exercises. To perform the strengthening exercises, the load was defined using the 1 repetition maximum (1RM) test, starting with 30 to 40% of the load defined for the upper limbs (ULs)19. The strengthening exercises for the lower limbs (LLs) were performed using the participant's own body weight. Every six sessions, the load was increased based on a new 1RM test for the ULs. The aerobic exercises were performed for 25 to 30 minutes on a treadmill or stationary bicycle, depending on the physical capacity and adaptation of each participant.

The modified BORG scale[13] and the Karvonen formula [Training Frequency = HRrest + % (HRmax - HRrest)][19] were used as effort parameters during training. The participant was instructed to maintain a perceived exertion level between 4 and 6 on the BORG scale and an intensity of 60 to 80% of HRmax. Whichever variable was reached first (without priority among them), the participant was instructed to slow down until he or she rested and then resume it.

At the end of the eighteen sessions, a new assessment was performed using all the scales and functional tests performed initially.

Twenty individuals were evaluated, two were removed from the study for not adhering to the training (frequency below 70%) and one for presenting a clinical complication (deep vein thrombosis) during the study.

RESULTS

Seventeen participants completed the study protocol, with a mean age of 55.5±14.2 years old and a mean hospital stay of 18.41±11.81 days, of which 16±9 days were spent in the ICU and 7±3.8 days in the ward. Of these, 14 had 20% to 80% lung parenchyma involvement as evidenced by computed tomography (CT) scan, and 10

(58.8%) did not require orotracheal intubation (OTI) during hospitalization. All participants were able to move independently, most lived in their own homes (13 (76.5%), had 1.0 (0.0-2.0) financial dependents, and 6 (35.3%) lived with at least two other people. The number of previous diseases calculated using the median was 1.0 disease (1.0-2.0) per participant. At least 15 (88.2%) were taking medication continuously, and the median was 3.0 (2.0-3.0) medications per day. No participant reported being a smoker, but 5 (29.4%) were former smokers. All participants had a normal chest, and no respiratory effort, cyanosis, clubbing, or fever.

Regarding physical activity, 10 (58.8%) were sedentary before COVID-19, and among those who did exercise, aerobic exercise predominated, with 6 (35.3%). The majority, 16 (94.1%) of the participants were normotrophic, and all were normotonic. The remaining data are shown in Table 1.

Table 1 – Description of the sample according to sociodemographic, economic, clinical characteristics and body composition, n=17, Goiânia, 2021

Variable	n (%)
Gender	
Male	6 (35,3)
Female	11 (64,7)
Most reported diseases	
Systemic Arterial Hypertension	7 (41,2)
Diabetes Mellitus	5 (29,4)
Body Composition	
Eutrophic	2 (11,8)
Overweight	8 (47)
Obese	7 (41,2)
Characteristics and Symptoms	
Normal Chest Expansion	13 (76,5)
Cough	6 (35,3)
Chest Pain	9 (52,9)
Weight Loss	7 (41,2)
Asthenia	2 (11,8)
Edema	2 (11,8)
Education	
Illiterate	2 (11,8)
Elementary School Complete	7 (41,2)
High School Complete	8 (44,1)
Marital Status (with and without partner)	
Without Partner	6 (35,3)
With Partner	11 (64,7)
Family Income (minimum wages*)	
Between 1 and 2	10 (58,8)
Between 2 and 3	4 (23,5)
Between 3 or more	3 (17,7)

* Minimum wage of R$1,100.00.

When dyspnea was assessed by the mMRC, there was an increase in the absolute frequency of participants who reported scores between zero and one on the scale and a decrease in the frequency of participants with scores two, three and four after supervised physical training (Figure 1).

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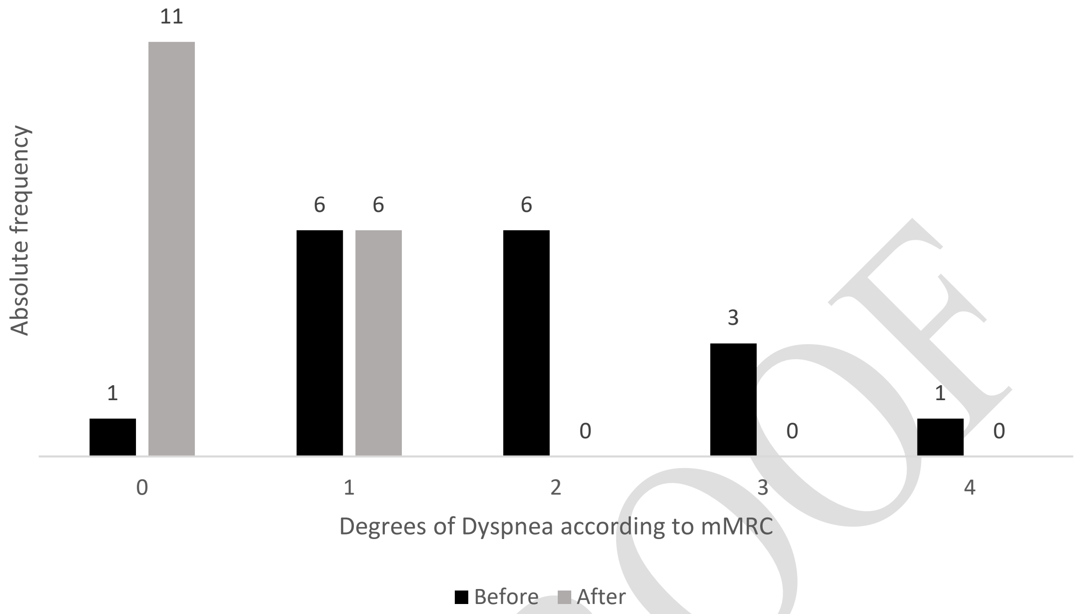
Figure 1 – Absolute frequency of the Medical Research Council dyspnea scale before and after supervised physical training, n=17, Goiânia, 2021.



There was an increase in the distance covered in the six-minute walk test (p<0.001) and an increase in MIP (p=0.005) after supervised physical training. A decrease in dyspnea during activities of daily living (p<0.001) was also identified at the end of supervised physical training compared to initial values, Table 2.

Table 2 - Comparison of initial and final parameters of the 6MWT, Manovacuometry, London Chest Activity of Daily Living Scale and 1-minute Sit-to-Stand Test, n=17, Goiânia, 2021.

Variable	Before	After	p
TC6min**			
Initial saturation (%)	97,0 (96,0-97,00)	97,00 (95,0-98,0)	0,282
Final saturation (%)	91,8 ± 4,6	93,7 ± 3,5	0,062
Distance traveled (m)	392,5 ± 105,9	484,7 ± 95,4	**<0,001***
Distance traveled (% of predicted)	73 ± 16,8	90 ± 13,6	
Distance traveled below predicted distance n (%)	16 (94,1)	11 (64,7)	
Manovacuometry	100,0 (60,0- 110,0)	110,0 (70,0-110,0)	**0,005***
Maximum inspiratory pressure (cmH2O)	9 (52,9)	6 (35,3)	
Maximum inspiratory pressure below predicted n (%)	102,6 ± 32,6	113,2 ± 32,0	0,170
Maximum expiratory pressure (cmH2O)	15 (88,2)	15 (88,2)	
LCADL***	25,8 ± 11,2	15,6 ± 4,5	**<0,001***
TSL1min****	16,0 (11,0-19,0)	21,5 (20,0-22,0)	**<0,001***

Paired t-test and Wilcoxon; *p<0.05; ** Six-minute walk test; *** London Chest Activity of Daily Living; **** Sit-to-stand test (repetitions in 1 minute)

All domains of the participants' quality of life assessment increased after supervised physical training, Table 3.

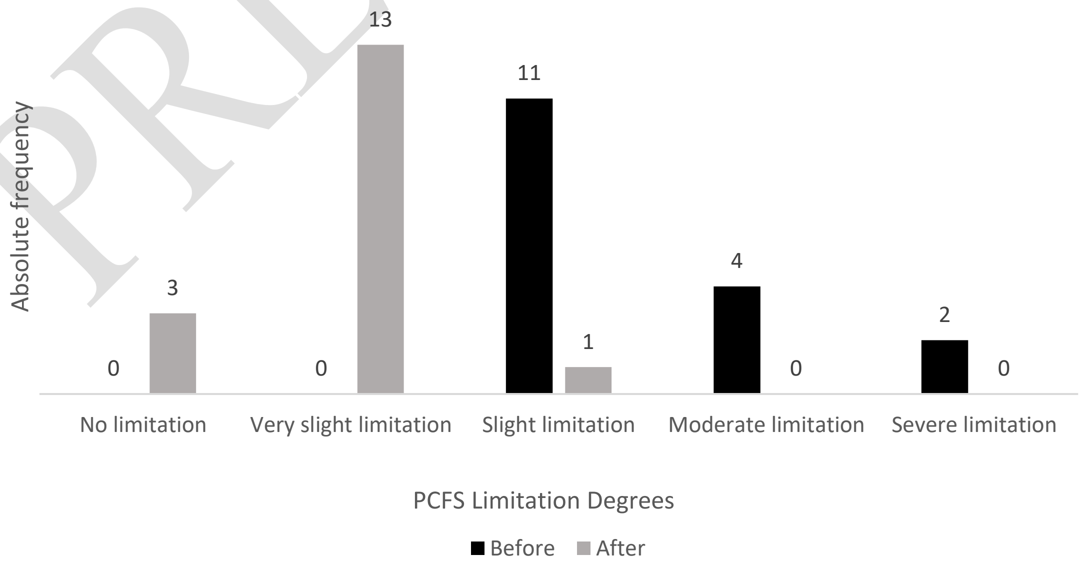
Table 3- Comparison of before and after values of the domains of the Short Form Health Survey 36 (SF-36), n=17, Goiânia, 2021.

SF36 Domains	Before	After	
Functional Capacity	30,0 (15,0-55,0)	60,0 (50,0-70,0)	**0,002***
Physical Aspects	0 (0,0-0,0)	50,0 (25,00-100,0)	**<0,001***
Emotional Aspects	0 (0-66,7)	100,0 (33,3-100,0)	**0,031***
Pain	41,0 (31,0-64,0)	62,0 (42,0-74,0)	**0,049***
Vitality	40,0 (25,0-60,0)	65,0 (60,0-80,0)	**0,002***
Social Aspects	50,0 (25,0-62,5)	75,0 (62,5-87,5)	**<0,001***
Mental Health	56,0 (32,0-72,0)	76,0 (68,0-88-0)	**<0,001***
General Health Status	60,0 (45,0-77,0)	72,0 (52,0-82,0)	**0,013***

*p<0,05

The PCFS, which before the intervention presented assessments distributed in mild, moderate and severe limitations, after the intervention the majority were between no limitation or very mild limitations (Figure 2).

Figure 2- Absolute frequency of the Functional Status Scale post-COVID-19 before and after supervised physical training, n=17, Goiânia, 2021.



DISCUSSION

The results of this study indicate that supervised physical training increased functional capacity, as evidenced by an increase in the distance covered in the 6MWT, an increase in the number of repetitions in the 1MWT, and, above all, in the self-reported scores in the PCFS. Furthermore, there was a reduction in dyspnea during daily activities, an increase in MIP, and an improvement in quality of life.

The effects of post-COVID-19 rehabilitation were investigated in a series of cases with an aerobic and muscle strengthening exercise protocol, similar to the protocol used in this study. There was a positive increase in the distance covered in the 6MWT of 16% after three months of cardiopulmonary rehabilitation9, while in the present study this increase was 23% after eighteen sessions. Another outpatient rehabilitation study showed that, after six weeks, there was an increase in the distance covered in the 6MWT of 62.9 meters,8 while in this study the increase was 92.2 meters, 29.3 meters more than that found in the study above and with a similar protocol time. These findings show that the time of the supervised physical training protocol is linked to the functional gains that the individual may acquire.

The present intervention study, through supervised physical training, showed an increase in the distance covered after 18 sessions. A retrospective study showed that more than half of the participants had a distance in the six-minute walk test with a median of 460 meters (427.5-525.0), after six months of follow-up by consultations. This is considered a good rate, being 92% of the predicted value (84-89%)[20], but it differed from the present study, which showed physical and functional improvement in less time, showing a minimum time of approximately 1 month and 15 days for positive functional gains in a supervised physical training protocol. Furthermore, it was shown that the faster physical training is instituted, the faster the individual's functional gains will be.

Similar to our study, participants in a retrospective case series with 23 participants showed improvement in locomotion capacity, functional independence and peripheral muscle strength after a period of 22.0 ± 9.49 days of rehabilitation[21]. The instrument used to measure independence was the functional independence measure (FIM), while in the present study, we used the PCFS specific to functional states related to COVID-19, the

SF-36 that assessed functional components related to quality of life and the LCADL that, indirectly, assessed functionality only related to dyspnea.

Another study evaluated thirty patients who had COVID-19 and underwent a rehabilitation program consisting of aerobic training, limb strengthening, and continuing education twice a week for six weeks. At the end, the patients showed improvement in the Incremental Shuttle Walking Test and the Endurance Shuttle Walking Test, with consequent improvement in functional capacity[7]. This cohort presented results similar to those found in the present study, but used different instruments in the process of evaluating the participants.

The PCFS was used in one study[8] and the initial evaluation showed a functional impairment grade of 2 (2.0-3.0) on the scale and at the end of the 6-week rehabilitation, this grade was 1 (0-1). The Euro-Qol 5D evaluated quality of life and in final scores indicated improvement in the variable with $p<0.001$ and the mMRC indicated improvement in the assessment of dyspnea after rehabilitation, also with $p<0.0018$. In this study, the mMRC and PCFS were used, as well as in the aforementioned study[8], and there were positive results with the reduction of dyspnea and increase in functionality, justifying the evidence of the effectiveness of supervised physical training targeted to demands and with individualized prescription.

When correlating the quality of life assessment[8] with that carried out in the present study, different instruments were used. While the SF-36 was used in the present study, the aforementioned study[8] used the Euro-Qol 5D, an instrument also validated and with great representation in health-related studies, as well as the SF-36, used in the present study. Both the results found in the present study and those found in the aforementioned study8 were relevant from a statistical point of view, justifying the fact that supervised physical training is an efficient strategy for improving quality of life after cases of COVID-19. Quality of life was also assessed in a retrospective study that used the EQ-5D-5L and WHODAS 2.0 one month after discharge of patients who had severe COVID-19, showing that the disease leaves sequelae that directly impact quality of life[22], as well as in the present study that showed poor quality of life after hospital discharge, but on the other hand, showed improvement after supervised physical training. No other studies that assessed quality of life after rehabilitation programs aimed at COVID-19 were found in the literature.

In the present study, an increase in maximum inspiratory pressure was found after supervised physical training. A previous study found low levels of respiratory muscle strength (inspiratory and expiratory) after hospital discharge due to COVID-1923, which coincides with the findings of this study, especially when considering that people who had COVID-19 have respiratory muscle dysfunctions for long periods that improve after physical training programs[23]. Although the protocol of this study did not directly include respiratory exercises, there was an improvement in inspiratory muscle strength because physical exercise itself is indirectly responsible for activating respiratory muscles and increasing inspiratory pressure, which has already been proven in studies with other populations[24].

Studies have shown a higher prevalence of middle-aged people infected with COVID-197, similar to the findings of this study, which was composed of people with an average age of fifty-five years. A case-control study conducted in Scotland indicated an increased risk for severe COVID-19 in older people. The severity of the disease increased 2.87 times and mortality 3.7 times for every 10 years of age[25]. The similarity of this study with the severity of the disease can be seen, since all participants had some degree of limitation, generating a different severity, observed in the data collected by the PCFS.

The majority of the participants in this study were sedentary, overweight or obese women. The rates of sedentary lifestyle found in this study are higher than those found in the general population of Brazil, where almost half of the total population does not follow the WHO recommendations of 150 to 300 minutes of moderate to vigorous physical activity per week[26].

Low levels of physical activity and high BMI have been reported as modifiable disease factors in patients who had COVID-1927. The pandemic, in its most critical period, led to a decrease in activities and an increase in confinement and social isolation, culminating in a reduced pace of physical exercise[28], which may justify the sedentary lifestyle and high BMI reported in the present study, whose data collection began a year and a half after the state of public calamity was declared. No studies were found that evaluated the level of physical activity prior to entry into post-COVID-19 rehabilitation programs.

This study found cough and chest pain as frequent symptoms, which are common in post-acute COVID-19. These two symptoms, together with dyspnea, were also found in a study that analyzed symptoms related to the disease[29], evidencing and justifying the persistence of such symptoms after the acute phase of the disease, as well as the emergence of deficiencies that affect the functionality of affected individuals.

Dyspnea is related to respiratory muscle strength, but also to exercise capacity, quality of life and functionality30. One of the instruments used in the present study was the LCADL, designed to assess people with severe COPD, i.e., obstructive diseases. Even though it is not a specific scale for restrictive diseases, a predominant characteristic of COVID-19, and because there is no other validated scale for this specificity, it was decided to use it in conjunction with other instruments such as the TSL1min, TC6min, mMRC, SF-36, PCFS and BORG scale. The LCADL was also used in a study in conjunction with the TSL30s, EQ-5D-5L, PCFS and BORG scale, showing that the greater the dyspnea, the worse the quality of life and functionality[30]. This correlation can be made in the present study, observing that the decrease in dyspnea was linked to the increase in functional capacity and the improvement in quality of life after the intervention. The study has limitations due to the small sample and the lack of a comparison group. The small sample is justified because data collection was carried out concomitantly with the vaccination program, reducing hospitalizations due to the disease and consequently the number of individuals meeting the inclusion criteria for the study. It was not possible to have a comparison group because during the study design period and part of the data collection, only COVID-19 groups were released for rehabilitation at the institution. Furthermore, most of the questionnaires and scales used for functional assessment are not specific for the assessment of COVID-19, but they are valid instruments for the functional assessment of most chronic respiratory diseases, paving the way for their use in other studies related to COVID-19.

Therefore, after investigating and analyzing the results of the present study, it is clear that the deficiencies and persistence of signs and symptoms of COVID-19 are still relatively new, despite the similarity of deficiencies and dysfunctions in different situations and scenarios of patients with nosology of the respiratory and systemic systems.

This understanding leads us to reflective and critical thinking about behavior and clinical and functional outcomes. Thus, further studies are needed to define new outcomes related to patients with COVID-19 sequelae. It is necessary to investigate other rehabilitation protocols that include multidisciplinary work. It is important to emphasize that an interprofessional team is beneficial in the evolution process of patients with diseases that affect multiple organs. Therefore, public policies should be discussed and practiced to improve the quality of life, functional and cardiopulmonary capacity of COVID-19 survivors.

CONCLUSION

Study participants benefited from supervised physical training, demonstrating an increase in functional capacity and inspiratory muscle strength, a reduction in dyspnea during daily activities, and improvements in aspects related to quality of life.

The study contributes to encouraging healthcare professionals and services to incorporate supervised physical training protocols into the list of cardiorespiratory and neuromusculoskeletal therapies for post-COVID-19 patients.

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SUPERVISED PHYSICAL TRAINING AFTER HOSPITALIZATION FOR COVID-19: AN EXPERIMENTAL STUDY

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