LONG COVID RECOVERY AND EXERCISE ADHERENCE: 32-MONTH STUDY

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ABSTRACT

Objective

To evaluate symptom progression in COVID-19 survivors, adherence to prescribed exercise therapy, and its association with pre-infection physical activity at 21 days (T0), 6 months (T1), and 32 months (T2) post-discharge.

Design

Retrospective longitudinal study in a hospital-based rehabilitation unit in Portugal. The cohort included 276 patients (mean age 56.6 ± 13.5 years) with confirmed SARS-CoV-2 infection.

Results

Adherence was higher among patients reporting prior physical activity (48.8%; $p = .003$). Symptom prevalence declined over time: dyspnea (T0 = 22.4%, T2 = 7.3%), fatigue (T0 = 32.4%, T2 = 14.5%), and pain (T0 = 17.6%, T2 = 4.8%). Asymptomatic cases increased from 27.4% (T0) to 54.5% (T2). Early adherence, particularly by day 15, was associated with continued participation at day 21, and adherence at day 21 correlated with reduced dyspnea at follow-up ($p = .02$). Importantly, patients who remained symptomatic at day 21 took significantly longer to recover ($t = –6.386$; $p < .001$), indicating this time point as a prognostic marker of delayed resolution of exercise-modifiable symptoms.

Conclusion

Early initiation of individualized, structured exercise proved safe, adaptable, and associated with reduced symptom burden, especially dyspnea. Persistence of symptoms at day 21 highlights the prognostic value of early follow-up and underscores the decisive role of timely rehabilitation engagement. Structured home-based and tele-rehabilitation programs

supported adherence and accessibility, reinforcing exercise as a cornerstone of long COVID management and potentially applicable to other post-respiratory rehabilitation contexts.

Keywords: Long COVID; Rehabilitation; Patient Compliance; Exercise Therapy

INTRODUTION

COVID-19 is a multisystemic disease with heterogeneous clinical presentations. While many individuals experience mild and self-limiting illness, the pandemic caused an estimated 15.9 million deaths globally in 2020–2021.[1] Although the World Health Organization (WHO) declared its end in May 2023, the long-term health consequences of SARS-CoV-2 infection remain a major concern.[2]

Long COVID, defined by the WHO as the persistence or emergence of symptoms three months after infection, lasting at least two months without alternative explanation, affects up to 50% of hospitalized patients [3] and as many as 70% of those with severe disease.[4] Fatigue, dyspnea, and cognitive impairment are among the most frequent sequelae, contributing to functional limitations, reduced quality of life, and delayed return to work.[5]

Multiple mechanisms have been implicated in its pathophysiology, including organ damage, chronic inflammation, endothelial dysfunction, microthrombosis, and autoimmunity.[6-9] Musculoskeletal impairment and critical illness myopathy, already well recognized before the pandemic,[10] are now acknowledged as contributors to long COVID, aggravating weakness and exercise intolerance.[8-10]

Physical inactivity is associated with worse COVID-19 outcomes, whereas higher cardiorespiratory fitness appears protective.[11] Individualized, low- to moderate-intensity exercise has been recommended to support recovery and improve function,[12] and phase-adapted rehabilitation strategies have been proposed.[13] However, uncertainties remain regarding the optimal exercise modality, intensity, and particularly the timing of intervention.[14]]

This study evaluated symptom progression and adherence to prescribed exercise therapy in COVID-19 survivors over 32 months. Special attention was given to the prognostic significance of day 21 post-discharge, to determine whether early rehabilitation engagement influences recovery trajectories and long-term outcomes

METHODS

Study Design and Ethical Approval

During the COVID-19 pandemic, to better characterize the clinical course and ensure continuity of Physical Medicine and Rehabilitation (PM&R) care initiated during hospitalization at Hospital Beatriz Ângelo (HBA), Portugal, patients were systematically evaluated in the hospital's outpatient PM&R clinic following discharge. Informed consent was obtained by phone and documented in the medical records, approved by the Ethics Committee. The study was approved by the research department and the Ethics Committee of HBA, with Ethics Approval Reference 3734/2021_MJHMAB/FB and 4692/2025_MJH/CL for study n.º576_LH n.º329. The data were collected between 1 May 2020 and 31 July 2025. Data were accessed for research purposes on the 31 July 2025. Only the medical authors who were responsible for monitoring the patients had access to the participants' identities.

Participants

Adult patients with clinically and laboratory-confirmed SARS-CoV-2 infection, diagnosed by reverse transcription polymerase chain reaction (RT-PCR), were included.

Patients were considered eligible after achieving clinical stability in the general COVID-19 ward. In-hospital exercise therapy was initiated in those meeting predefined clinical safety criteria, including comprehensive assessment of respiratory, cardiovascular, and neurological systems, as well as hematologic and laboratory parameters [15,16] (see S1 Appendix).

The final sample included 276 hospitalized patients, aged 20 to 86 years (mean = 56.6 ± 13.5), of whom 194 (71.1%) were male. Among them, 163 patients (59.7%) required admission to the intensive care unit (ICU), mainly due to hypoxemic respiratory failure. Invasive mechanical ventilation (IMV) was necessary in 79 patients (29.2%), and prone positioning was frequently employed.Prior physical activity was reported by 97 patients (35.1%) and was defined as meeting the World Health Organization's recommended levels: 150–300 minutes of moderate-intensity or 75–150 minutes of vigorous-intensity aerobic activity per week.[17]

The most common comorbidities were hypertension (58.3%), obesity (57.4%), dyslipidemia (41.1%), and diabetes mellitus (32.4%). Other relevant conditions included psychiatric disorders (10.2%), malignancy (7.0%), chronic pulmonary disease (6.6%), and asthma (6.1%). Notably, 45.5% of patients had no comorbidities.

In-Hospital Rehabilitation Program

During isolation, the PM&R department developed an exercise plan to continue rehabilitation started during hospitalization. After clinical stabilization (typically by day 2–3), the team provided education and individualized instruction.

Patients received a printed guide with 10 standardized exercises (breathing, limb and trunk strength, and balance), illustrated with photos, plus a resistance band (TheraBand®). Intensity was progressively adapted (3–20 repetitions), with adjustments based on tolerance under physiotherapist supervision. Oxygen saturation and heart rate were monitored with a pulse oximeter, and symptoms were assessed using the Modified Borg Scale (mBorg). Exercise was discontinued if saturation dropped >4% from baseline, fell below 90%, or if fatigue, dyspnea, or pain exceeded 3 on the mBorg. Progression, including increased repetitions, was implemented under physiotherapist supervision.

Post-Discharge Home-Based Program

Upon discharge, all instructional materials and equipment except for the pulse oximeter were provided to patients to continue the home-based program. Exercise compliance was monitored through structured follow-up, including three telephone contacts by the clinical team, forming part of a tele-rehabilitation strategy to support adherence and address any emerging complications related to the prescribed exercise plan. The first call occurred between the 5th and 10th day after discharge, the second on the 15th day (both by physiotherapists), and the third on the 21st day, conducted by a physician. Patients were also encouraged to begin walking after the isolation period, with appropriate safety precautions (Figure 1).

Due to fluctuations in healthcare response capacity during the pandemic, only 231 of the 276 patients (83.7%) received at least one follow-up call. Due to the absence of adherence data, the remaining 45 patients (16.3%) could not be included in analyses examining exercise compliance or symptom progression related to follow-up timing. Of those contacted, 93 (33.7%) received the first call, 63 (22.8%) received the second, and 227 (82.2%) were reached on the 21st day post-discharge.

Outpatient Follow-Up and Clinical Monitoring

Compliance with the prescribed exercise program was assessed, and symptoms were recorded during the day-21 teleconsultation. If symptoms or disability persisted, a face-to-face PM&R consultation was scheduled between the second and fourth months, post-discharge, depending on appointment availability.

Pain was defined as new-onset or worsening of prior symptoms. When appropriate, a 6-minute walk test (6MWT) was performed during in-person visits to assess oxygen desaturation, heart rate, and functional capacity. Referrals to other specialties and neuropsychology were made when needed.[18] Follow-up diagnostics were limited due to infection risk and logistical constraints.

Rehabilitation Prescription and Long-Term Monitoring

During in-person PM&R consultations, patients received a comprehensive clinical assessment and a tailored rehabilitation prescription (RP), which included physiotherapy and occupational therapy, primarily delivered at the hospital. Follow-up appointments were scheduled every 2 to 3 months. Monitoring continued until rehabilitation-responsive symptoms (e.g., fatigue, dyspnea, pain, myalgias, peripheral sequelae, muscle weakness, imbalance, reduced effort tolerance) had resolved, or until the study database closed at 32 months.

Study Variables

Variables included demographic data (age, sex), ICU admission, IMV, discharge date, prior physical activity, comorbidities, follow-up contact dates, exercise adherence, and symptom evolution (see S2 Appendix).

Data Analysis

Statistical analysis was performed using **IBM** Statistical Package for the Social Sciences (SPSS), version 28 (IBM Corp., Armonk, NY, USA). Descriptive and frequency analyses were conducted for demographic and clinical variables. Frequency analyses, chi-square tests of independence, and independent-sample t-tests were used to assess associations between the study variables. Patients who did not receive any follow-up calls (n = 45;16.3%) were excluded from analyses involving exercise adherence and its association with outcomes, due to lack of relevant data. However, they were retained in overall descriptive statistics where applicable. No data imputation was performed. Full details of the statistical procedures are provided in S3 Appendix.

RESULTS

Exercise adherence

Most patients adhered consistently to the prescribed exercise program throughout follow-up (Figure 2). A significant association was found between adherence at day 15 and adherence at day 21 post-discharge (Table 1; $\chi^2 = 4.712$; $p = .03$), with 83.6% of individuals who exercised on day 15 also adhering on day 21 (Table 1).

Table 1. Association between early exercise adherence and day 21 adherence in covid-19 survivors

Adherence to exercise		21st day after discharge		
		No	Yes	$\chi 2$
5-10th day after discharge	No	1 (33.3%)	2 (66.7%)	
	Yes	9 (10.3%)	78 (89.7%)	1.552 (*p*=.21)
15th day after discharge	No	1(100.0%)*	0 (0.0%)*	
	Yes	10(16.4%)*	51 (83.6%)*	4.712 (*p*=.03)

*p <.05

Symptom Burden and Adherence

Intervention strategies aimed at enhancing patients' understanding of the importance of exercise for physical rehabilitation promoted sustained adherence, even 21 days post-discharge. Additionally, analysis of long COVID symptoms revealed that the majority (83.2%) of patients who performed the exercises on day 21 did not experience dyspnea post-discharge ($\chi 2(1) = 5.289$, p = .02) (Table 2). The average follow-up time in the PM&R consultation was 6.1 months (M = 6.1; SD = 6.2).

Table 2. Day 21 Exercise and Post-COVID Symptom Burden

		Adherence to exercise		
Symptoms		No	Yes	$\chi 2$
Pain	No	32 (18.5%)	141 (81.5%)	
	Yes	8 (21.6%)	29 (78.4%)	0.193 (*p*=.66)
Fatigue	No	28 (17.5%)	132 (82.5%)	
	Yes	12 (23.5%)	39 (76.5%)	0.915 (*p*=.34)
Dyspnea	No	31 (16.8%)*	154 (83.2%)*	
	Yes	9 (36.0%)*	16 (64.0%)*	5.289 (*p*=.02)
Neurologic sequelae	No	39 (19.3%)	163 (80.7%)	
	Yes	1 (12.5%)	7 (87.5%)	0.231 (*p*=.63)
Myalgias	No	37 (18.6%)	162 (81.4%)	
	Yes	3 (27.3%)	8 (72.7%)	0.509 (*p*=.48)

Decline in muscular	No	35 (18.7%)	152 (81.3%)	
strength	Yes	5 (21.7%)	18 (78.3%)	0.121 (*p*=.73)
Imbalance	No	37 (18.5%)	163 (81.5%)	
	Yes	3 (30.0%)	7 (70.0%)	0.817 (*p*=.37)
Decreased effort	No	40 (19.5%)	165 (80.5%)	
tolerance	Yes	0 (0.0%)	5 (100.0%)	1.205 (*p*=.27)
Paresthesias	No	39 (19.0%)	166 (81.0%)	
	Yes	1 (20.0%)	4 (80.0%)	0.003 (*p*=.96)

*$p<.05$

Effect of Prior Physical Activity on Adherence

Patients were asked about their exercise habits prior to COVID-19 infection. A significant association was observed between previous habits and adherence on day 21 ($\chi2(1) = 8.991$, p = .003), Nearly half of adherent patients (48.8%) reported meeting WHO physical activity guidelines prior to COVID-19 infection. (Table 3).

Table 3. Pre-Infection Physical Activity and Day-21 Exercise Adherence

Adherence to exercise		Previous exercise habits		$\chi2$
		No	Yes	
5-10th day after discharge	No	1 (33.3%)	2 (66.7%)	
	Yes	41 (50.6%)	40 (49.4%)	0.346 (*p*=.56)
15th day after discharge	No	1 (100.0%)	0 (0.0%)	

	Yes	27 (49.1%)	28 (50.9%)	1.018 (p=.31)
21st day after discharge	No	29 (78.4%)*	8 (21.6%)*	
	Yes	82 (51.2%)*	78 (48.8%)*	8.991 (p=.003)

*p<.01*Long-Term Symptom Evolution*

Most patients were aged 55–64 years (34.4%, 50.0%, and 28.0% at T0, T1, and T2, respectively). Males predominated at T0 (65.6%) and T2 (72.0%), while females were more frequent at T1 (58.3%). Symptoms were assessed at follow-up consultations every 2–3 months, with data compared at T0 (21 days), T1 (6 months), and T2 (32 months) post-discharge. Figure 3 shows symptom evolution across these time points.

At T0, the most common symptoms were fatigue (32.4%), dyspnea (22.4%), and pain (17.6%); at T1, pain (37.5%), fatigue (34.4%), and dyspnea (28.1%); and at T2, fatigue (14.5%), dyspnea (7.3%), and reduced strength (5.5%). The proportion of asymptomatic patients increased from 27.4% at T0 to 54.5% at T2.

A significant association was found between symptoms reported on the day-21 phone call and delayed resolution of exercise-modifiable symptoms, with symptomatic patients taking longer to become asymptomatic (t = -6.386; p < .001) (Table 4).

Table 4. Impact of Day-21 Symptom Status on Time to Resolution of Exercise-Modifiable Symptoms

	Time to resolution of exercise-modifiable symptoms		
Symptomatic patients	n	*M (SD)*	*t*
No	73	4.32 (3.80)	
Yes	95	9.48 (6.06)	-6.386 (p<.001)

DISCUSSION

This retrospective longitudinal study highlighted the potential benefits of early, structured exercise therapy in post-COVID rehabilitation and provided novel data on symptom evolution up to 32 months after hospital discharge.

The cohort was predominantly male and middle-aged, with a high prevalence of comorbidities - particularly hypertension, followed by obesity and dyslipidemia. Most participants were aged between 55 and 64 years. In this study, the majority of patients with long COVID were male at T0 and T2, and female at T1. Previous studies identified a higher risk of developing long COVID in association with several factors, including female sex, middle age, obesity, infection severity, hospital admission (particularly requiring oxygen therapy), symptom burden (such as dyspnea and chest pain), and pre-existing comorbidities such as asthma.[19-22] While the age distribution in this cohort aligns with prior studies,[22] the predominance of male patients contrasts with most reports.[20] This discrepancy may reflect the higher proportion of male hospitalizations during the study period. These comorbidities are well-established risk factors for severe COVID-19 and have been linked to delayed recovery and greater symptom burden in post-acute and long COVID populations. In this cohort, early adherence to the exercise regimen, particularly by day 15, was strongly associated with continued participation through day 21, underscoring the value of early rehabilitation engagement. Moreover, patients with a history of physical activity prior to infection demonstrated better adherence post-discharge, reinforcing the influence of lifestyle factors on recovery. Notably, adherence at day 21 was associated with reduced dyspnea at final consultation.

An important finding of this study is the identification of day 21 as a critical prognostic time point. Patients who still reported symptoms and did not adhere to the exercise program at this stage took significantly longer to become asymptomatic. This emphasizes that, while the benefits of exercise in long COVID are recognized, the timing of initiation is decisive: patients who fail to engage in exercise early—within the first three weeks after discharge—are at substantially higher risk of prolonged recovery. Clinically, this suggests that day-21 follow-up is valuable not only for monitoring adherence but also for identifying high-risk patients who may require intensified rehabilitation strategies and closer supervision.

Long-term symptom monitoring revealed a progressive decline in key symptoms (fatigue, dyspnea, and pain) and an increase in asymptomatic individuals over time. However, patients who remained symptomatic at day 21 experienced significantly slower recovery, suggesting early symptom persistence as a potential prognostic marker of prolonged rehabilitation.

The pathophysiological mechanisms underlying long COVID remain incompletely understood. Prolonged systemic inflammatory responses have been proposed as a potential mechanism for long COVID, particularly in patients with mild acute infection who develop persistent symptoms despite no detectable organ damage.[19,23] Several mechanisms have been implicated in the pathogenesis of long COVID, including alterations in the angiotensin-converting enzyme 2 (ACE2) pathway and dysregulation of the renin–angiotensin–aldosterone system (RAAS)[24], endothelial dysfunction [25], neuromuscular impairment26, and autonomic dysregulation.[27] Given these complex mechanisms, interventions that target systemic inflammation and functional impairment—such as exercise—are increasingly supported by evidence. Exercise plays a key role in post-COVID rehabilitation, not only by enhancing functional capacity but also through its anti-inflammatory effects. Regular moderate-intensity exercise reduces systemic inflammatory mediators (CRP, IL-6, TNF-α) through improved immune regulation, increased anti-inflammatory cytokines, and enhanced vagal tone. Given the contribution of chronic low-grade inflammation to long COVID, exercise may directly modulate its pathophysiology and support recovery. [28,29]

This study underscores the importance of individualized rehabilitation strategies and multidisciplinary care in long COVID.30 Exercise interventions were adapted to patient tolerance and adjusted progressively based on symptom response, accommodating the heterogeneity of clinical presentations. Supervision by physiotherapists and physicians, including structured telephone follow-up, enabled safe and remote engagement, particularly during isolation periods. These findings highlight the utility of tele-rehabilitation in supporting adherence and extending access to care, reinforcing its role within comprehensive post-COVID rehabilitation protocols.

Limitations

This study has several limitations. First, pre-existing symptomatology data were unavailable, potentially confounding persistent symptom interpretation. Second, symptom severity assessment was limited by data granularity constraints. Third, excluding patients without follow-up calls may have introduced selection bias. Additionally, this single-center study lacked a control group of patients discharged after non-COVID illnesses. Since prolonged symptoms may occur after community-acquired pneumonia, findings may have broader relevance beyond COVID-19

CONCLUSION

This study evaluated post-discharge symptoms in COVID-19 survivors and their adherence to a rehabilitation program for long COVID. The findings reinforce the importance of early and individualized rehabilitation, particularly through structured therapeutic exercise. Interventions were safe, adaptable, and associated with reduced symptom burden—most notably dyspnea.

An important finding of this study was the identification of day 21 as a critical prognostic point: patients who remained symptomatic and did not adhere to exercise at this stage took significantly longer to recover. This underscores that early initiation of low- to moderate-intensity exercise under professional supervision is decisive for optimizing recovery, beyond its role as a functional enhancer and immune modulator.

Additionally, the successful implementation of tele-rehabilitation highlights its potential to enhance accessibility and support patient management. Collectively, these results suggest that structured and early rehabilitation strategies may be extended to other populations recovering from severe respiratory illnesses.

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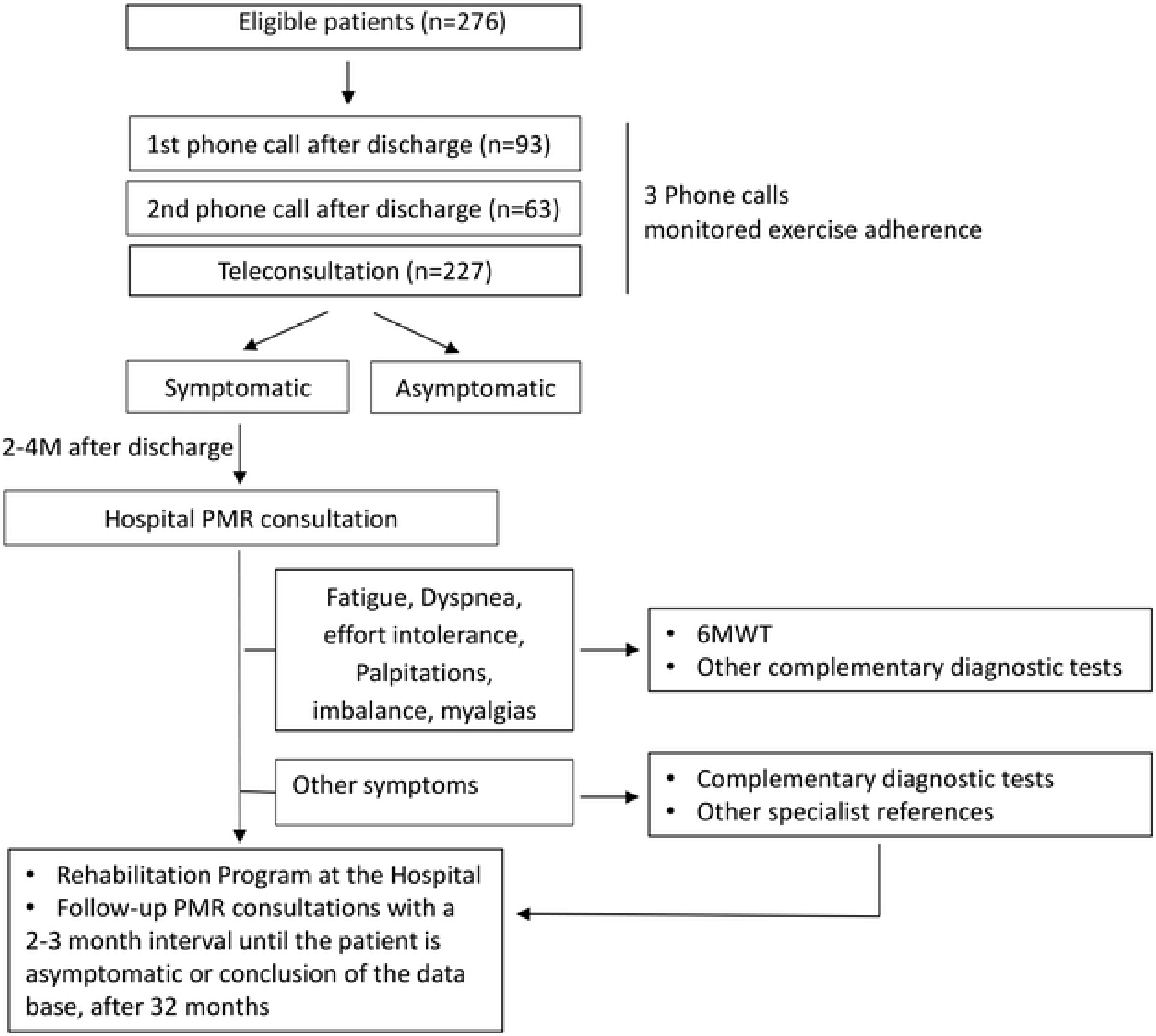
Figure Legends

Figure 1. *Flow chart of the study*

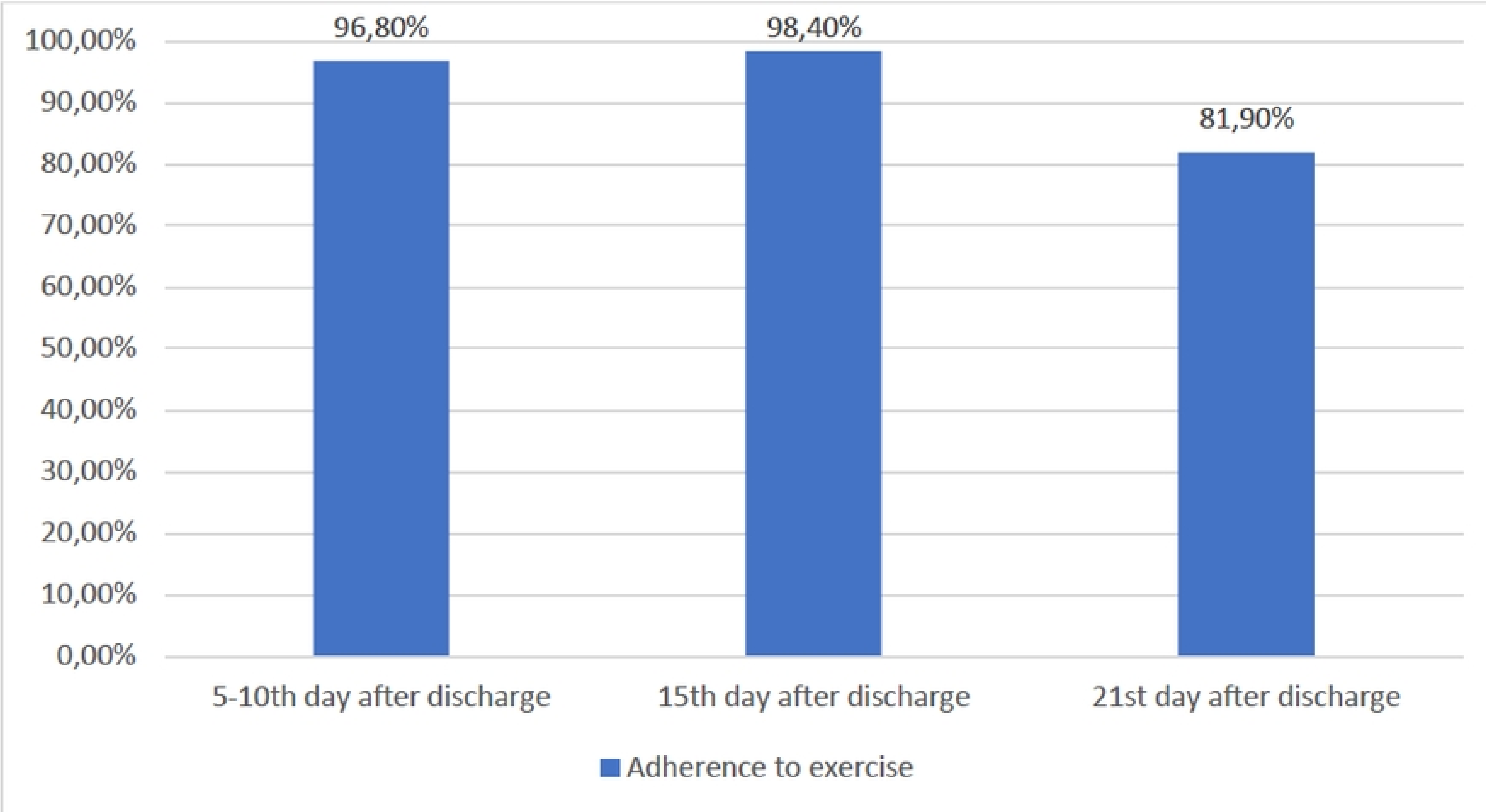
Figure 2. *Adherence to exercise at three follow-up points*

Figure 3. *Evolution of the most frequent post-COVID symptoms at 21 days (T0), 6 months (T1), and 32 months (T2) after discharge*

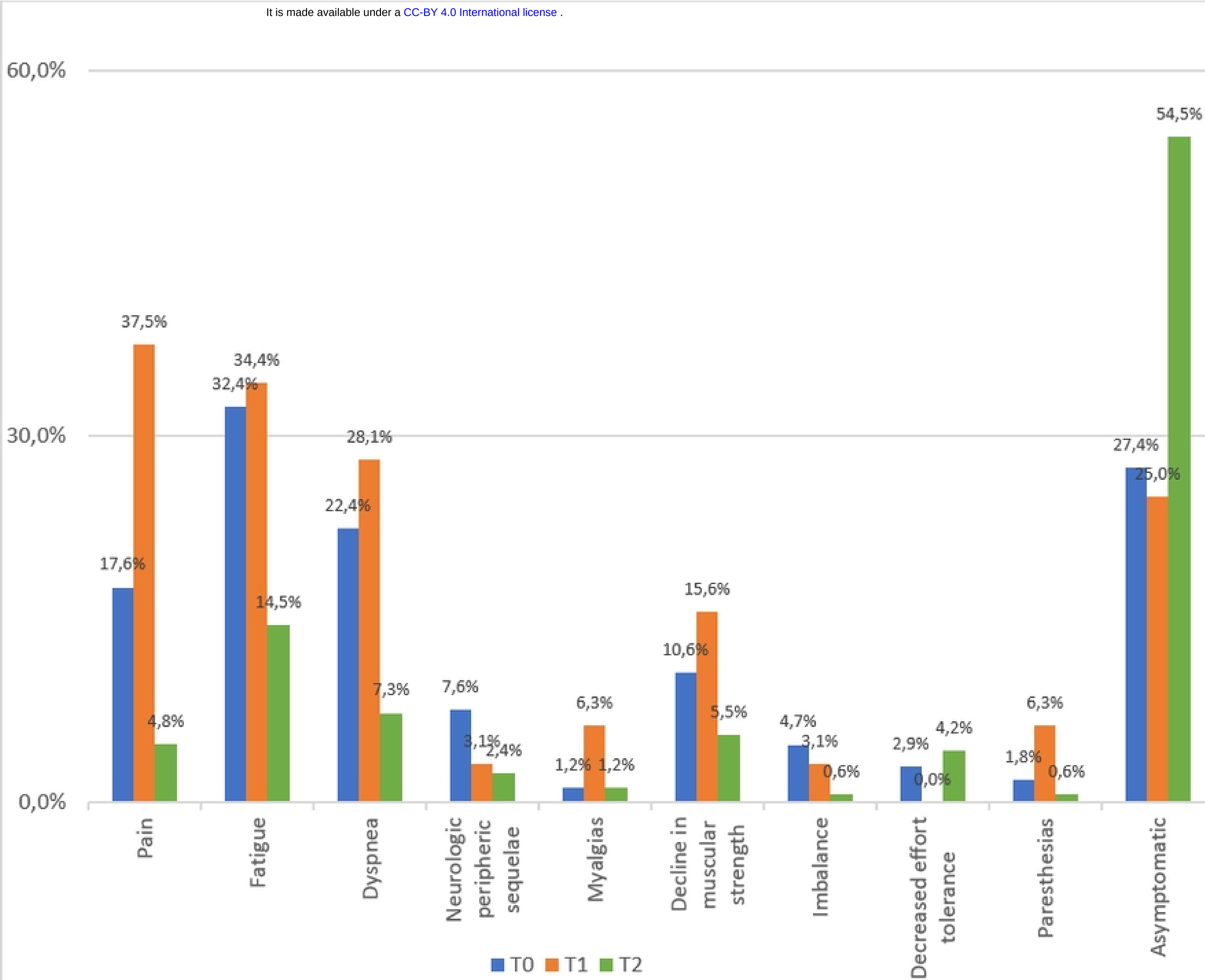
Figure 1. *Flow chart of the study*



Figure


96,80%
98,40%
81,90%
100,00%
90,00%
80,00%
70,00%
60,00%
50,00%
40,00%
30,00%
20,00%
10,00%
0,00%
5-10th day after discharge
15th day after discharge
21st day after discharge
Adherence to exercise

Figure


60,0%
30,0%
0,0%
37,5%
17,6%
4,8%
34,4%
32,4%
14,5%
28,1%
22,4%
7,3%
7,6%
3,1%
2,4%
6,3%
1,2%
1,2%
15,6%
10,6%
5,5%
4,7%
3,1%
0,6%
2,9%
0,0%
4,2%
6,3%
1,8%
0,6%
54,5%
27,4%
25,0%
Pain
Fatigue
Dyspnea
Neurologic peripheric sequelae
Myalgias
Decline in muscular strength
Imbalance
Decreased effort tolerance
Paresthesias
Asymptomatic
T0
T1
T2

Figure