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ORIGINAL RESEARCH

Capacity and functional profile of post-COVID-19 individuals: one-year follow-up

Capacidade e perfil funcional de indivíduos pós covid–19: seguimento de um ano

Capacidad y perfil funcional de personas post–COVID–19: seguimiento a un año

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ABSTRACT | Patients recovering from COVID-19 often exhibit health characteristics shaped by the disease's clinical manifestations. Following the pandemic progression, it has become increasingly important to assess the impact of these manifestations on the quality of life of post-COVID-19 patients. This study analyzed the profiles of individuals infected during the 2020 and 2021 pandemic waves. A cross-sectional study was conducted with patients referred to rehabilitation following COVID-19 infection. Assessment tools included the Modified Borg Scale, the Medical Research Council (MRC) Dyspnea Scale, and the EQ-5D-3L and EQ-VAS quality of life instruments, alongside the Post-COVID Functional Scale (PCFS). Additional functional evaluations were performed using spirometry, manovacuometry, manual dynamometry, the 6-minute walk test (6MWT), and the sit-to-stand test. A total of 286 patients (mean age 49.01±16.86 years) participated, grouped by year of infection: 2020 (n=118) and 2021 (n=168). Results indicated a worsening of symptoms in 2021, including increased hospitalization rates, and longer ward and ICU stays. Health-related quality of life also declined significantly, particularly regarding mobility (p=0.02), pain/discomfort (p=0.001), and usual activities (p=0.004). Persistence of symptoms and resulting decline in functionality suggest increased disease severity in 2021. The second COVID-19 wave thus exacerbated the disease's impact, leading to more frequent functional and systemic impairments, underscoring the heightened need for post-COVID rehabilitation to improve quality of life.

Keywords | Pandemic; Rehabilitation; SARS-CoV-2..

RESUMO | Pacientes recuperados da infecção por COVID-19 apresentam características consequentes das manifestações clínicas da própria doença. A evolução da pandemia ressalta a importância de analisar o impacto destas manifestações na qualidade de vida dos pacientes pós COVID-19. O objetivo do estudo foi analisar o perfil de pacientes pós-COVID-19 infectados em 2020 e 2021. Foi realizado um estudo transversal com pacientes encaminhados para reabilitação pós-COVID-19. Utilizaram-se como instrumentos de medida a Escala Modificada de Borg, Escala de Dispneia *Medical Research Council* (MRC), os instrumentos de qualidade de vida EQ-5D-3L e EQ-VAS, além da Escala Funcional Pós-COVID (PCFS). Foram realizados os testes de espirometria, manovacuometria, dinanometria manual, teste de caminhada de 6 minutos (TC6) e teste de sentar e levantar. Participaram 286 pacientes (49,01±16,86 anos), subdivididos nos anos 2020 (n=118) e 2021 (n=168).

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Os resultados apontaram uma piora nos sintomas em 2021, com aumento nos números de internações, dias de admissão na enfermaria e na UTI. Houve um agravo na qualidade de vida relacionada à saúde, onde os domínios mobilidade (p=0,02), dor/mal-estar (p=0,001) e atividades habituais (p=0,004) obtiveram maior significância. A persistência de sintomas e a consequente redução da funcionalidade indicaram o aumento da gravidade da doença em 2021. A segunda onda da COVID-19 aumentou a gravidade da doença e resultou em um maior número de disfunções funcionais e sistêmicas, impactando na qualidade de vida e evidenciando a necessidade de reabilitação.
Descritores | Pandemia; Reabilitação; SARS-CoV-2.

RESUMEN | Pacientes que se recuperaron de la infección por COVID-19 presentan características resultantes de las manifestaciones clínicas de la propia enfermedad. La evolución de la pandemia resalta la importancia de analizar el impacto de estas manifestaciones en la calidad de vida de los pacientes post-COVID-19. Este estudio tuvo el objetivo de analizar el perfil de pacientes post-COVID-19 infectados en 2020 y 2021. Se realizó un estudio transversal con pacientes remitidos para rehabilitación post-COVID-19. Se utilizaron como instrumentos de medida la Escala Modificada de Borg, la Escala de Disnea *Medical Research Council* (MRC), los instrumentos de calidad de vida EQ-5D-3L y EQ-VAS, además de la Escala Funcional Post-COVID (PCFS). Se realizaron pruebas de espirometría, manovacuometría, dinamometría manual, prueba de caminata de 6 minutos (TC6) y prueba sentado-de pie. Participaron 286 pacientes (49.01±16.86 años), subdivididos en los años 2020 (n=118) y 2021 (n=168). Los resultados mostraron un empeoramiento de los síntomas en 2021, con un aumento en los números de internaciones, días de admisión en la enfermería y en la UCI. Hubo un deterioro en la calidad de vida relacionada con la salud, y los dominios movilidad (p=0.02), dolor/malestar (p=0.001) y actividades habituales (p=0.004) tuvieron una mayor significación. La persistencia de los síntomas y la consiguiente reducción de la funcionalidad indicaron el aumento de la gravedad de la enfermedad en 2021. La segunda ola de COVID-19 aumentó la gravedad de la enfermedad y provocó un mayor número de disfunciones funcionales y sistémicas, lo que impactó la calidad de vida y resaltó la necesidad de rehabilitación.
Palabras clave | Pandemia; Rehabilitación; SARS-CoV-2.

INTRODUCTION

From the emergence of the new coronavirus (SARS-CoV-2) through November 3, 2021, a total of 247,472,724 confirmed cases and 5,012,337 deaths have been officially reported to the World Health Organization (WHO)[1]. WHO declared COVID-19 a public health emergency of international concern due to its high transmission rate, elevating it to pandemic status[2].

Over time, COVID-19 underwent mutations which while not always harmful, can provide advantages to the virus, such as increased transmissibility or the ability to evade immune responses[3]. COVID-19 transmission leads to infections with varying severity and clinical manifestations[4]. These are highly variable and, like the virus's lethality rate, remain a serious concern for both the general population and healthcare providers[2,5]. Additionally, research suggests that certain comorbidities may exacerbate COVID-19 severity, complicating recovery[6].

While the mortality rate is concerning and should not be minimized, most COVID-19 patients recover. However, even mildly symptomatic individuals can experience a range of lingering dysfunctions that may persist for extended periods, and evidence indicates that symptoms can last up to nine months post-recovery[7,8].

The post-COVID-19 patient profile has been examined by several studies, identifying patterns by gender, age, schooling level, and symptomatology[9,10]. Yet, more than 18 months into the pandemic, few studies have compared the profiles of recovered patients over time in relation to clinical characteristics, severity, and symptom persistence. Additionally, quality of life impacts over time remain largely unmeasured. Although COVID-19 manifestations are now well documented, potential long-term implications, particularly regarding functionality, have yet to be fully explored. Thus, this study analyzed the demographic and clinical profiles of post-COVID-19 patients, focusing on the functional capacity and key characteristics of those infected in 2020 and 2021.

METODOLOGY

The study was conducted at Clínica-Escola de Fisioterapia da Universidade Estadual do Centro-Oeste (CEFISIO/UNICENTRO) between June 2020 and

June 2021. Participants were selected through convenience sampling via referrals from the Regulation Department of the municipality of Guarapuava, Paraná , Brazil, to CEFISIO, a designated reference clinic for post-COVID-19 care.

A total of 286 individuals participated in the study, with 118 patients assessed in 2020 and 168 in 2021. Inclusion criteria required patients to be 18 years or older, with a confirmed COVID-19 diagnosis via RT-PCR or rapid testing, accompanied by clinical manifestations ranging from mild ageusia and anosmia to dyspnea and severe respiratory failure[11]. Only patients who had completely ceased viral transmission and were referred to the physiotherapy service were included. Five patients who declined to participate, along with ten others who were unable to undergo the tests—eight in 2020 and seven in 2021—were excluded.

Initially, an identification questionnaire was applied for sample characterization, recording information related to the COVID-19 diagnosis and active phase of the disease, including the date of diagnosis and discharge, the type of confirmatory test, presenting symptoms, hospitalization history, ICU admissions, and the need for invasive or non-invasive mechanical ventilation (IMV or NIV) and oxygen therapy.

Post-COVID assessment evaluated the need for home oxygen therapy and the persistence of symptoms. Fatigue was measured using the modified Borg scale, which ranges from zero to ten, in which zero indicates no fatigue and ten signifies maximum fatigue[12]. Dyspnea was assessed using the Medical Research Council (MRC) dyspnea scale, a widely used tool for evaluating dyspnea in respiratory patients. This scale has been validated in Brazil for patients with chronic obstructive pulmonary disease (COPD) and consists of five levels, ranging from zero (no dyspnea) to four (severe dyspnea), requiring patients to indicate the option that best reflects their current condition[13].

Health-related quality of life (HrQoL) was assessed using the EQ-5D-3L and EQ-VAS instruments (registration number 40769_TOU, EuroQol Research Foundation). EQ-5D-3L is a descriptive system for evaluating HrQoL across five domains: mobility, self-care, usual activities, pain/discomfort, and anxiety/depression[14]. Results from each domain are combined to generate 243 possible health states, which are translated via a EuroQol calculator into a single health status value ranging from zero to one.

EQ-VAS is a standard 20 cm vertical visual analog scale, numbered from zero to 100, in which zero indicates the worst imaginable clinical condition and 100 is the best imaginable health state. Participants are asked to mark on the scale how they perceive their current health status[15].

Functionality was assessed using the Post-COVID Functional Scale (PCFS), translated into Portuguese[16]. This scale evaluates limitations in daily tasks and activities, both at home and in work or school environments, as well as lifestyle changes. A flowchart guided the application, which offers six classification levels: zero (no symptoms), one to four (increasing levels of functional limitation), and five (death).

Respiratory function was measured using a spirometer (Spirobank II), assessing Forced Vital Capacity (FVC) and Forced Expiratory Volume in the first second (FEV1)[17]. For this test, patients were seated and used a mouthpiece connected to the spirometer, with a nose clip to prevent air leakage. During the maneuver, patients were instructed to inhale deeply through the mouthpiece and then exhale forcefully until completing exhalation. The prediction equation used for reference values was: height × age coefficient × weight coefficient ± constant[18]. Respiratory muscle strength was evaluated using an analog manovacuometer (Marca Médica) to measure maximum inspiratory pressure (MIP) and maximum expiratory pressure (MEP), following the recommendations of the Brazilian Society of Pulmonology and Phthisiology[19]. The reference values for both spirometry and manovacuometry measurements were calculated based on equations specific to the Brazilian population.[20,21].

Handgrip strength was measured by recording the maximum isometric force exerted on a dynamometer (Saehan Medical), which registers force in kg. Three measurements were taken on the dominant hand with intervals to prevent muscle fatigue, and the highest value was recorded[22,23]. Functional capacity was assessed using the six-minute walk test (6MWT). Participants were instructed to walk a 30-meter distance back and forth as many times as possible, with the path marked by colored tapes and cones at each end. Near the starting point, baseline measurements of blood pressure (BP), oxygen saturation (SpO_2), and heart rate (HR) were taken with participants at rest. SpO_2 and HR were then monitored every two minutes, and all variables were reassessed at the test's conclusion. Throughout the walk, an examiner followed each participant from

a posterolateral position, holding the pulse oximeter to monitor variables and ensure participant safety, while providing verbal encouragement as standardized by the American Thoracic Society (ATS)[24]. Reference values were calculated using the equation proposed by Enright and Sherrill (1998)[25].

The sit-and-stand test was also conducted. Participants, seated in a chair with back support, were instructed to stand up and sit down five times consecutively upon the researcher's command. The total time taken to complete the test was recorded[26].

Data analysis

Data were presented as mean, standard deviation, and raw values with frequency distribution. After performing the normality test, a t-test for unpaired samples was applied to analyze continuous data, and the chi-square (χ^2) test was used for categorical data analysis. For this analysis, patients were divided into two subgroups: the 2020 group, consisting of post-COVID patients assessed between June and December 2020, and the 2021 group, consisting of patients assessed between January and June 2021. Statistical analyses were conducted using Biostat 5.0, with a significance level set at $p<0.05$.

RESULTS

Table 1 presents the sample characteristics, showing a heterogeneous distribution with significant differences between individuals infected in 2020 and 2021.

During the active phase of COVID-19, symptom severity worsened in 2021, particularly with respect to dry cough, fatigue, sputum production, dyspnea, chills, and diarrhea. Hospitalizations, as well as the number of in the ICU and general wards also increased. The need for respiratory support, including oxygen therapy, rose significantly in 2021. Detailed figures can be seen in Table 2.

Table 1. Sample characteristics

Variable	Total (n=286)	2020 (n=118)	2021 (n=168)	p-value
Age (years)	49.01±16.86	53.23±16.08	43±16.15	**<0.0001**
Weight (kg)	79.9±18.00	79.09±19.98	80.92±16.44	0.153
Height (cm)	1.66±0.9	1.66±0.10	1.65±0.99	0.346
BMI (Kg/cm2)	28.23±7.2	28.04±6.67	28.36±7.58	0.148
Female	164 (57.4)	63(53.3)	101(60)	
Male	122 (42.6)	55(46.6)	67(40)	
Associated diseases				
None	149(52)	59(20.6)	90(31.4)	
One disease	63(22)	37(12.9)	26(9.1)	χ^2=71.55
Two or three diseases	45(15.7)	14(4.9)	31(10.8)	**p<0.0001**
More than three diseases	29(10)	8(2.8)	21(7.2)	
Smoking				
Yes	31 (10.8)	11(3.8)	20(6.9)	
No	179 (62.6)	86(30.1)	93(32.5)	χ^2=15.89
Former smoker	76 (26.6)	21(7.3)	55(19.2)	**p=0,007**
Profession				
Self-employed	27 (9.4)	18(6.3)	9(3.1)	
Health professional	20(7)	11(3.8)	9(3.1)	
Retired	77 (26.9)	22(7.7)	55(19.2)	
Home worker	9 (3.1)	4(1.4)	5(1.7)	χ^2=23.19
Registered	100 (35)	39(13.6)	61(21.3)	**p=0.002**
Education professional	22 (7.7)	11(3.8)	11(3.8)	
Student	16 (5.6)	12(4.2)	4(1.4)	
Not informed	15(5.)	1(0.3)	14(4.9)	
Physical activity				
Yes	60 (20.9)	38(13.3)	22 (7.6)	χ^2=192.83
No	226 (79)	80 (28)	146 (51)	**p<0.0001**
Days between Covid confirmation and post evaluation	57.43±46.84	72.60±34.20	41.95±26.54	**<0.0001**

BMI: Body mass index

Table 2. Symptomatology, hospitalization and use of resources for respiratory support

Variable	Total (n=286)	2020 (n=118)	2021 (n=168)	p-valor	χ^2
Symptoms					
Asymptomatic	17(5.94)	7(2.44)	10(3.5)		
1 to 3 symptoms	22(7.69)	15(5.2)	7(2.44)		
4 to 9 symptoms	102(35.6)	51(17.8)	51(17.8)	p=0.08	χ^2=15.762
10 to 15 symptoms	145(50.7)	45(15.7)	100(34.4)		
Fever	176 (61.5)	88(30.7)	145(50.7)	p=0.05	χ^2=3.0005
Dry cough	201 (70.2)	70(24.5)	131(45.8)	**p<0.001**	χ^2=14.965
Fatigue	233 (81.4)	88(30.7)	145 (50.7)	**p<0.001**	χ^2=11.493
Sputum	75(26.2)	16(5.6)	59(20.6)	**p<0.001**	χ^2=18.023
Dyspnea	195(68.1)	66(23)	129(45.1)	**p<0.001**	χ^2=17.450
Sore throat	110(38.4)	44(15.3)	66(23)	p=0.615	χ^2=0.972
Headache	196(68.5)	80(28)	116(40.5)	p=0.53	χ^2=1.250
Myalgia/Arthralgia	196(68.5)	83(29)	113(39.5)	p=0.89	χ^2=0281
Chills	141(49.3)	42(14.7)	99(34.6)	**p<0.001**	χ^2=17.731
Nausea/Vomiting	105 (36.7)	38(13.2)	67(23.4)	p=0.07	χ^2=2,.500
Nasal congestion	82(28.6)	29(10.1)	53(18.5)	p=0.09	χ^2=2.02
Diarrhea	136(47.5)	49(17.1)	87(30.4)	**p=0.02**	χ^2=4.267
Anosmia	163(57)	69(24.1)	94(32.8)	p=0.535	χ^2=0.001
Ageusia	163(57)	69(24.1)	94(32.8)	p=0.535	χ^2=0.001
Total symptoms	5.44±3.60	7.38±3.69	4.10±2.83	**p<0.001**	
Admission					
Yes	125(43.7)	29(10.1)	96(33.5)	**p<0.001**	χ^2=30.710
No	161(56.3)	89(31.)	72(25.1)		
ICU days	5.19±1.06	2±0.5	6.6±1.5	**p=0.001**	
Ward days	4.15±2.55	2.4±1.16	4.77±3.5	**p<0.001**	
Hospitalization days	7.2±3,56	3.56±1.6	8.67±4.5	**p<0.001**	
IMV	11(3.8)	1(0.3)	10(3.5)	p=0.06	χ^2=5.610
NIV	38(13.2)	12(4.2)	26(9.1)	p=0.37	χ^2=1.94
Oxygen therapy	135(47.2)	37(12.9)	98(34.2)	**p=<0.001**	χ^2=22.983

ICU: Intensive care unit; IMV: Invasive mechanical ventilation; NIV: Non-invasive ventilation.

As for health-related quality of life, assessed with the EQ-5D-3L and EQ-VAS instruments, there was a notable decline in 2021 compared with 2020. Significant differences were observed in the domains of mobility (p=0.02), pain/discomfort (p=0.001), and usual activities (p=0.004). The use of home oxygen therapy and persistent symptoms such as fatigue and dyspnea, along with mild functional limitations, were present in both groups but increased in 2021, underscoring the intensification of COVID-19 severity and the associated reduction in functionality. These results are detailed in Table 3.

Comparison of pulmonary function, functional capacity, and musculoskeletal function across the evaluation years pointed to a significant decline in test values in 2021 (Table 4).

Table 3. Study results

Variable	Total (n=286)	2020 (n=118)	2021 (n=168)	p-value	χ^2
General health condition (0-100)	77.49±17.41	81.5±16.5	74.4±15.5	0.05	
QoL index	0.73±0.21	0.77±0.21	0.70±0.21	**0.04**	
QoL questionnaire domains					
Mobility					
No problems	217(94.7)	97(33.9)	120(42)		
Some problems	66(23)	21(7.3)	45(15.7)	**p=0.02**	χ^2=11.65
Full problem	3(1)	0	3(1)		

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Variable	Total (n=286)	2020 (n=118)	2021 (n=168)	p-value	χ^2
Personal care					
No problems	254(88.8)	108(37.7)	146(51.1)		
Some problems	24 (8.4)	9(3.1)	15(5.2)	p=0.07	χ^2=8.412;
Full problem	8(2.8)	1(0.3)	7(2.4)		
Pain/discomfort					
No problems	161(56.3)	77(26.90	84(29.4)		
Some problems	105(36.7)	33(11.5)	72(25.2)	**p=0,001**	χ^2=17.82;
Full problem	20(6.9)	8(2.8)	12(4.1)		
Anxiety/depression					
No problems	137(47.9)	58(20.3)	79(27.6)		
Some problems	111(38.8)	46(16.1)	65(22.7)	p=0.06	χ^2=8.926;
Full problem	38(13.2)	14(4.9)	24(8.3)		
Usual activities					
No problems	179(62.6)	85(29.7)	94(32.9)		
Some problems	84(29.3)	27(9.4)	57(19.9)	**p=0.004**	χ^2=15.35
Full problem	23(8)	6(2.1)	17(5.9)		
Home oxygen therapy					
Yes	56(19.5)	8(2.8)	48(16.7)	**p<0.001**	χ^2=25.65;
No	230(80.5)	110(38.4)	120(41.9)		
PCFS					
No limitation	100(34.9)	47(16.4)	53(18.5)		
Insignificant limitation	57(19.9)	31(10.8)	26(9.1)		
Mild limitation	64(22.3)	27(9.4)	37(12.9)	**p<0.001**	χ^2=31.35;
Moderate limitation	41(14.3)	9(3.1)	32(11.2)		
Severe limitation	24(8.5)	4(1.4)	20(7.1)		
Persistent fatigue					
Yes	180(63)	63(22)	117(40.9)	**p=0.002**	χ^2=4.645
No	106(37)	55(19.2)	51(17.8)		
Borg scale – fatigue	4.46±3.01	4.05±3.31	4.80±2.70	0.102	
Persistent dyspnea					
Yes	149(52)	49(17.1)	117(34.9)	**p=0.002**	χ^2= 9.068;
No	137(48)	69(24.1)	68(23.9)		
MRC – dyspnea					
0	137(48)	69(24.1)	68(23.8)		
1	45(15.5)	19(6.6)	26(9)		
2	36(12.5)	10(3.5)	26(9)	**p<0.001**	χ^2=31.35;
3	37(13)	12(4.3)	25(8.7)		
4	31(11)	8(3)	23(8)		

QoL: quality of life; PCFS: Pos-Covid functional scala; MRC: Medical Research Council

Table 4. Values of tests performed

Variable	Total (n=286) mean±SD	2020 (n=118) mean±SD	2021 (n=168) mean±SD	p-value
MIP %prev	75.93±33.25 80%	89.17±32.9 87%	65.3±29.72 75%	**<0.001**
MEP % pev	63.38±29.28 64%	72.22±30.5 65%	56.33±26.09 62%	**<0.001**

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Variable	Total (n=286) mean±SD	2020 (n=118) mean±SD	2021 (n=168) mean±SD	p-value
FVC % prev	3.05±1.04 82%	3.33±0.96 90%	2.71±1.03 75%	**<0.001**
FEV1 % prev	2.56±1 78%	2.81±0.94 90%	2.25±0.9 66%	**<0.001**
6MWD % prev	365.6±111.6 58%	380±108.3 64%	343.8±109.3 53%	**0.004**
HGS % pre	32.7±13.06 84%	34.5±14.82 90%	29.89±11.12 79%	**0.024**
TSL5X %prev	17.27±7.12 49%	15.50±5.11 53%	18.71±.10 45%	**0.001**

MIP: maximum inspiratory pressure; MEP: maximum expiratory pressure; FVC: forced vital capacity; FEV1: forced expiratory volume in the first second; 6MWD: distance covered in the six-minute walk test; HGS: handgrip strength; TSL5X: sit and stand test five times; % prev: percentage of predicted.

DISCUSSION

This study described the primary characteristics of COVID-19 recovery patients who required cardiorespiratory rehabilitation in 2020 and 2021. Our analyses indicate that disease severity was greater in the second wave, resulting in higher hospitalization rates and an increased incidence of long-term sequelae.

Mean age of recovered adults was 53.23 ± 16.08 years in 2020 and 43 ± 16.15 years in 2021. Previous studies have shown that, in 2020, older adults were the most affected by severe COVID-19 cases. Additionally, COVID-19 immunization began in late January 2021, prioritizing older adult populations[27,28]. According to Victora et al.[27], vaccination coverage reduced mortality among individuals over 80 by April 2021. These findings support the observed age variation in this study. As vaccination efforts accelerated, expanding to new priority groups through July 2021, the mean age of infected individuals decreased, resulting in a higher contamination rate among younger adults and adolescents in the present study.

Our findings indicate increased symptom severity among patients during the active COVID-19 period in 2021 compared with 2020, especially in terms of specific symptoms. This heightened severity may be attributable to greater exposure to viral loads, potentially due to new virus variants. A genomic epidemiology study conducted between March 2020 and January 2021 found that the first pandemic wave began in March 2020, peaked in early May, and stabilized from June to November 2020. However, December 2020 saw an increase in cases with the emergence of the Brazilian P.1 variant, which quickly became the predominant strain in the country[29]. Research by Faria et al.[30] and Challen et al.[31] showed that the P.1 variant has acquired 17 mutations, resulting in viral loads up to ten times higher which has led to more severe symptoms and a greater risk of death.

A substantial proportion of patients (48%) were found to have comorbidities. Additionally, the number of smokers, former smokers, sedentary individuals, and those with more than three underlying conditions was notably higher in 2021 than in 2020. Evidence suggests that individuals with coexisting health conditions are at increased risk of complications and hospitalization due to COVID-19, with these factors often contributing to higher mortality rates[32]. Obesity and a sedentary lifestyle have also been identified as significant risk factors for severe COVID-19 outcomes. BMI calculations in this study indicated that participants were above their ideal weight[33,34]. Cai's study[35] further associated smoking with a more severe and progressive form of COVID-19. Along with increased viral loads, these factors likely contributed to the greater frequency of unfavorable clinical outcomes in 2021.

The present study identified a significantly higher hospitalization rate in 2021 (57.14%) compared with 2020 (24.6%). According to the Pan American Health Organization (PAHO), hospitalization rates in Chile increased by over 70% among individuals under 39 years old in 2021. In Brazil, most hospitalizations were among people in their 40s, findings that align with our results[36]. Freitas et al.[37] noted that a shift in age demographics—where younger patients and those without pre-existing conditions represented an increasing proportion of severe cases and deaths—characterized this second wave. The resulting rise in hospitalizations contributed to a strain on local health systems in 2021, including ICU overcrowding.

Comparing hospitalization durations across the two years, 2021 showed a considerable increase with an average stay of 6.6±1.5 days. This rise likely reflects

both the heightened severity of cases and advancements in the management of critically ill patients. Another study observed differences in ICU admissions between the first and second COVID-19 waves, revealing progress in patient care management but no notable improvement in overall prognosis[38]. As a result, patients spent more time in the ICU before hospital discharge, although many experienced severe post-discharge effects requiring rehabilitation.

Wiersinga et al.[39] indicated that hypoxemic respiratory failure was the primary reason for ICU admissions, with invasive mechanical ventilation (IMV) use rates ranging from 29% to 91%. Another study noted that 31% of COVID-19 patients needed advanced ventilatory support, and survival rates were higher for patients using non-invasive ventilation (NIV) than for those on IMV[40].

The review by Martinez et al.[41] highlights that NIV was not considered a first-line treatment strategy in 2020. This reluctance stemmed from the widespread virus transmission, limited clinical experience with COVID-19, and lack of appropriate interfaces available in ICUs. By 2021, however, research began to associate NIV with improved oxygenation, reduced dyspnea, and lower rates of endotracheal intubation, leading to the development of new safety and management protocols[42,43,44]. Consequently, in our study, the increased proportion of individuals requiring NIV as essential respiratory support during the disease period in 2021 is justifiable. After all, in addition to the increased infection severity and prolonged ICU stays that accelerated the need for hospitals and home respiratory support, there was greater definition of treatment.

Longitudinal follow-up studies have demonstrated that severe COVID-19 cases can result in long-term sequelae, with pulmonary abnormalities potentially persisting for up to seven months following diagnosis[45]. In a study analyzing data from 4,182 newly diagnosed COVID-19 cases, 558 patients (13.3%) experienced symptoms lasting 28 days or more, 189 patients (4.5%) had symptoms that persisted for eight weeks, and 95 patients (2.3%) reported symptoms lasting 12 weeks or longer. The persistence of symptoms beyond 12 weeks has been termed "long COVID," characterized by fatigue, headache, dyspnea, and anosmia. Moreover, the experience of more than five symptoms during the first week of illness was linked to the likelihood of long-term sequelae[46]. The observed decline in pulmonary function, along with the deterioration of functional and musculoskeletal conditions in our sample—particularly in 2021—highlights the significant impact on quality of life, functionality, and symptomatology following COVID-19. These findings align with previous studies of other coronaviruses, such as SARS and MERS, which reported similar respiratory, musculoskeletal, and neuropsychiatric sequelae, indicating shared pathophysiological mechanisms associated with post-acute COVID-19[47].

Changes in mobility and daily activities, alongside persistent symptoms such as pain, dyspnea, and fatigue, were the most frequently reported issues among individuals in our study. In a related study, the authors found a prevalence of symptoms in post-discharge assessments of patients who had been hospitalized for COVID-19, including dyspnea (83%), cough (54%), and chest pain (27%). Additionally, functional impairment was evident in over half of the individuals, characterized by a decrease in FVC and total lung capacity (TLC). The patients also showed poor performance in the 6MWT and a reduction in carbon monoxide diffusion (DLCO) measured 16 days post-hospital discharge. The authors suggested that COVID-19 could lead to sequelae such as pulmonary fibrosis[48]. Consistent with these findings, our study identified significant changes in respiratory function, respiratory muscle strength, and functional capacity, all of which worsened with increasing severity. This highlights a late stage in the recovery process and underscores the importance of ongoing monitoring, thorough assessments, and the promotion of adequate rehabilitation for any persistent long-term sequelae[7].

Despite the aggravating factors that contributed to more severe conditions in individuals assessed in 2021, there was a shorter interval between COVID-19 diagnosis and post-disease assessment during that year. It is believed that this reduction in time was influenced by the increase in research conducted in 2021, which underscored the importance of early rehabilitation, the multidisciplinary approach as a critical component of recovery, and the development of studies and programs aimed at raising awareness, educating, and supporting patients in the post-disease phase[49]. This factor, along with other outcomes, probably contributed to the unsatisfactory results observed in the assessments conducted in 2021. Nonetheless, the temporal evolution of functionality in these patients can be affected by both early and late rehabilitation, making continued rehabilitation from hospitalization and immediately after discharge highly recommended[50].

Considering the severity of the disease in hospitalized patients, the increase in hospitalization duration, the complexity of sequelae leading to a consequent reduction in quality of life (QoL), and the urgent need for appropriate rehabilitation interventions, it is crucial to prioritize protective measures against COVID-19. During the second wave, the effectiveness of these protective measures diminished significantly; one study indicated a marked decline in mask use and adherence to social distancing behaviors, primarily due to fatigue related to compliance and economic pressures faced by the population[51].

The line of care also extends to the need for the healthcare network to provide early prevention and rehabilitation for patients with post-COVID sequelae, who will need care after hospital discharge[52]. Rehabilitation requires new guidelines as most established recommendations are based on rehabilitation management of complications from epidemics prior to COVID-19[53].

A study focusing on the remodeling of rehabilitation services concluded that effective contingency planning is essential, incorporating phases that positively impact health services, crisis management, multidisciplinary collaboration, and the overall health of the post-COVID-19 population[54]. Consequently, rehabilitation for post-COVID-19 patients is critical for transforming the health system and facilitating patient recovery. This adaptation not only enhances the quality of care but also improves outcomes during and beyond the pandemic[55].

However, this study was conducted with a sample of patients from a single city in Southern Brazil, which restricts the generalizability of the results. Additionally, because this study used a spontaneous demand sample, individuals with other conditions were not assessed.

CONCLUSION

In light of these findings, we conclude that individuals requiring physiotherapeutic rehabilitation after COVID-19 infection during the second pandemic wave exhibited higher prevalence of functional and systemic dysfunctions. The second COVID-19 wave appears to have intensified disease severity, as evidenced by increased hospitalizations, longer ward and ICU stays, worsened quality of life, persistent symptoms, and reduced functionality. Further studies should evaluate the association between these variables and disease severity. Additionally, it is essential to establish a structured post-COVID-19 care network, given the high incidence of musculoskeletal and cardiorespiratory dysfunctions. This highlights the importance of comprehensive assessment and thorough analysis of all SARS-CoV-2 infection aspects to ensure safe and effective rehabilitation.

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