Balance and functional capacity following physiotherapy interventions in long COVID cases in the Brazilian Amazon

Equilíbrio e funcionalidade pós-intervenções fisioterapêuticas entre casos de COVID longa na Amazônia

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Abstract

Introduction: Post-COVID-19 syndrome, also known as long COVID, is characterized by persistent muscle weakness, episodes of dyspnea and fatigue, impaired motor coordination, superficial sensory deficits, balance disturbance, and memory deficits. Evidence-based neurofunc-functional physiotherapy has emerged as a treatment option for restoring balance and functional capacity in these patients. **Objective:** To evaluate the effects of a neurofunctional physiotherapy protocol on balance and functional outcomes in individuals with long COVID. **Methods:** This nonrandomized (quasi-experimental), uncontrolled, paired pre-post, prospective interventional case series included 10 participants with neuromuscular manifestations related to COVID-19, who completed 25 sessions of the neurofunctional protocol. The variables analyzed were balance (Berg Balance Scale), basic activities of daily living – BADLs (KATZ Index), and instrumental activities of daily living - IADLs (Lawton Scale). Qualitative data were summarized by absolute and relative frequencies and quantitative data were expressed as means ± standard deviation. Pre-post differences were analyzed using the Wilcoxon test. **Results:** The majority of participants were women (70%), aged between 37 and 64 years (50.80 ± 8.85), with systemic arterial hypertension (70%). There were statistically significant post-intervention improvements in balance ($p = 0.034$) and IADLs ($p = 0.026$). **Conclusion:** The neurofunctional physiotherapy protocol effectively improved balance and increased independence in IADLs in individuals with long COVID, although no significant gains were observed in BADLs.

Keywords: Long COVID. Post-acute COVID-19 syndrome. Postural balance. Functional status. Physical therapy modalities.

Resumo

Introdução: *Entre as sequelas da COVID-19, destacam-se a fraqueza muscular, quadros agudos de dispneia e cansaço, comprometimento da coordenação motora, sensibilidade superficial, equilíbrio e memória, caracterizando a síndrome pós-COVID-19 ou COVID longa. A fisioterapia neurofuncional, embasada em evidências, é uma opção de tratamento para reabilitar o equilíbrio e a funcionalidade.* ***Objetivos:*** *Avaliar o equilíbrio e a funcionalidade em indivíduos com COVID longa, antes e depois da aplicação de um protocolo de fisioterapia neurofuncional.* ***Métodos:*** *Trata-se de um ensaio clínico não randomizado (quasi-experimental), não controlado, pareado antes e depois, do tipo prospectivo, série de casos, de abordagem quantitativa, com 10 participantes que apresentaram manifestações neuromusculares associadas à COVID-19, submetidos a 25 sessões do protocolo neurofuncional. As variáveis analisadas foram: equilíbrio (Escala de Berg), atividades básicas de vida diária - ABVDs (Escala de KATZ) e atividades instrumentais de vida diária - AIVDs (Escala de Lawton). As variáveis qualitativas foram analisadas por frequências absolutas e relativas e as quantitativas por médias e desvio-padrão. Já na abordagem analítica, avaliou-se o pareamento dos dados antes e após a intervenção através do teste Wilcoxon.* **Resultados:** *A maioria dos participantes era do gênero feminino (70%), com idade entre 37 e 64 anos (50,80 ± 8,85) e hipertensão arterial sistêmica (70%). A intervenção fisioterapêutica mostrou alterações benéficas no equilíbrio (p = 0,034) e AIVDs (p = 0.026) da amostra, sendo estatisticamente significante.* ***Conclusão:*** *O protocolo de fisioterapia neurofuncional foi eficiente no ganho de equilíbrio e maior independência nas AIVDs na COVID longa, sem alterações significativas nas ABVDs.*

Palavras-Chave: *COVID longa. Síndrome de COVID-19 pós-aguda. Equilíbrio postural. Estado funcional. Modalidades de fisioterapia.*

Introduction

The substantial burden of COVID-19 cases and deaths worldwide indicates a notable prevalence of sequelae, which are especially frequent among patients with the most severe forms of the disease. The most common sequelae include muscle weakness, acute episodes of dyspnea and fatigue, impaired motor coordination, superficial sensory deficits, balance disturbance, and memory impairments.[1,2]

According to the Brazilian Ministry of Health, from March 27, 2020, to October 26, 2024, Brazil reported 38,984,103 confirmed COVID-19 cases and 713,966 deaths, corresponding to a case fatality rate of 1.83%. A study by the Oswaldo Cruz Foundation (Fiocruz Minas) found that half of those affected developed long COVID sequelae, highlighting the urgent need for research on this condition.[3,4]

Neurofunctional physiotherapy is an important evidence-based strategy for addressing balance impairment and functional limitations in individuals with long COVID. During the pandemic, this modality played a critical role in restoring autonomy and functional capacity in patients with COVID-19-related sequelae.[5,6]

Given the limited body of research on the neuromuscular sequelae of long COVID in the Brazilian Amazon, this study aimed to evaluate the effects and benefits of neurofunctional physiotherapy in individuals from this region.[7,8]

Methods

This nonrandomized (quasi-experimental), uncontrolled, paired pre-post, prospective interventional case series used a quantitative approach to assess the effects of a physiotherapy intervention. The study forms part of the project "Epidemiology and health interventions related to the follow-up of neuromuscular manifestations associated with COVID-19 in the Tucuruí Lake Region", approved by the Research Ethics Committee of Pará State University (UEPA) under protocol number 5.615.423.

The research was conducted in Tucuruí, a municipality located in the southeastern region of Pará state. According to the Brazilian Institute of Geography and Statistics (IBGE),[9] the municipality covers 2,084.289 km^2 and has a population of 91,306 inhabitants, most of whom live in urban areas. All interventions were performed at the Laboratory of Physiotherapy Resources and Scientific Evidence (LARTEF) (Res. No. 3983/23-CONSUN UEPA).

The sample consisted of 10 residents of Tucurui (seven women and three men) aged 18 years or older, who presented with COVID-19-related neuromuscular manifestations from 2020 onwards and were monitored from October 2022 to December 2023. Exclusion criteria were being bedridden, exhibiting cognitive impairment, inability to verbalize, or orthopedic injuries, surgeries, traumas or any other condition preventing travel to LARTEF.

Thirty of the initially screened individuals were excluded for not meeting the inclusion criteria. All participants provided written informed consent, and all data were anonymized for analysis.

Intervention protocol

Participants were recruited through announcements on social media, posters, and local radio broadcasts. Each underwent an initial assessment to establish therapeutic goals, followed by implementation of the neurofunctional physiotherapy protocol.

The intervention incorporated techniques such as proprioceptive neuromuscular facilitation (PNF),[10] the Bobath neurodevelopmental method,[11] kinesiotherapy,[12] and electrotherapy,[13] which have been used to manage other viral infections affecting the nervous system.[14-17]

Participants completed 25 60-minute sessions, held two to three times a week. Sessions included a warm-up (15 minutes on a treadmill or exercise bike), one to five sets of exercises, repetitions of 20-30 seconds to one minute, and one- to two-minute rests between sets. Exercises targeted joint mobility, active, active-assisted, and active-resisted movements, motor coordination, PNF, balance, and stretching of the upper (UL) and lower limbs (LL) (Table 1).

The first session focused on UL and spinal exercises, and the second on LL and balance training. For those attending three times weekly (n = 2), the third session again targeted LL and balance. Session frequency was determined by participant availability, work schedules, and transportation limitations. No comparative analysis was performed between participants attending twice versus three times per week.

Table 1 - Description of techniques included in the protocol

Technique	Specification	Application per session
PNF[10]	All positions for UL and LL	8 minutes
Kinesiotherapy[12]	Joint mobilization and strengthening exercises for UL and LL using a ball, dowel, elastic band, free weights, and ankle weights (progressively increased according to each participant's ability). Spinal mobility exercises. Paraspinal and core muscle strengthening. Balance training in single-leg stance on the floor, a wobble board, balance board, and proprioceptive disc, and dynamic movements that challenge the center of gravity, combined with secondary tasks.	24 minutes
Neurodevelopmental Bobath method[11]	Inhibitory tapping; pressure tapping; alternating tapping; sliding tapping (UL, LL, and trunk).	10 minutes
Electrotherapy[13*]	TENS (frequency = 2 Hz, pulse width = 250 Hz, Burst mode) and ultrasound (1 MHz for deep tissues / 3MHz for superficial tissues, continuous mode).	20 minutes (TENS) and 4 minutes (ultrasound)
Stretching	Whole-body and muscle-specific stretches (UL, LL and trunk).	3 minutes and 30 seconds**

Note: PNF = proprioceptive neuromuscular facilitation; UL = upper limbs; LL = lower limbs; TENS = transcutaneous electrical nerve stimulation. *Used only when the participant reported pain in any location. **30 seconds for whole-body stretches and 30 seconds for each of the following muscles: deltoid, triceps, dorsal muscles, quadriceps, hamstrings, and triceps surae.

Assessment instruments

The following variables were analyzed: age, sex, education level, occupation, balance, basic activities of daily living (BADLs), and instrumental activities of daily living (IADLs). Balance was assessed using the Berg Balance Scale,[18] BADLs with the Katz Index of Independence in Activities of Daily Living,[19] and IADLs with the Lawton Instrumental Activities of Daily Living Scale.[20]

The Berg Balance Scale[18] evaluates functional balance (static and dynamic) through 14 tasks scored from 0 to 4 points each, with the total score ranging from 0 (high risk of falls) to 56 (minimal risk). The Katz index[19] assesses six BADLs: bathing, dressing, toileting, transferring, continence, and feeding, which are scored from 0 (complete dependence) to 6 (full independence). The Lawton Scale[20] measures seven instrumental activities: telephone use, traveling, shopping, meal preparation,

housekeeping, medication management, and financial management. Scores < 5 indicate total dependence, while a maximum of 21 reflects independence.

Data were tabulated, stored and analyzed using Microsoft Office Excel 2010[21] and R software, version 3.6.1.[22] Descriptive statistics included absolute and relative frequencies for qualitative variables and means with standard deviations (± SD) for quantitative variables. Pre- and post-intervention comparisons were performed using the Wilcoxon test.[23] Statistical significance was set at $p < 0.05$.

Results

The sample comprised three men (30%) and seven women (70%), aged between 37 and 64 years (50.80 ± 8.85). Age distribution was as follows: 50-59 years (n = 4; 40%), 40-49 years (n = 3; 30%), 60-69 years (n = 2; 20%), and 30-39 years (n = 1; 10%).

In terms of education, five participants (50%) had completed high school, two (20%) had postgraduate qualifications, and the remaining three were distributed across incomplete elementary education, undergraduate, and master's degrees. Occupations included housewives (n = 3; 30%), administrative assistants (n = 2; 20%), teacher (n = 1, 10%), building technician (n = 1; 10%), school lunch worker n = 1; 10%), social worker (n = 1; 10%), and security guard (n = 1; 10%).

With respect to comorbidities, 70% of participants (n = 7) had systemic arterial hypertension (SAH), 20% (n = 2) unspecified rheumatism, 20% (n = 2) fibromyalgia, 20% (n = 2) diabetes mellitus, and 10% (n = 1) myasthenia gravis. Before the intervention, three participants were at risk of falling (46-56 on the Berg Balance Scale), but showed improved balance after completing the physiotherapy protocol. On the Lawton IADL scale, four individuals initially exhibited partial dependence (scores > 5 and < 21), but progressed to full independence (21 points) post-intervention (Table 2).

The Wilcoxon test showed significant improvements in the Lawton ($p = 0.026$) and Berg scores ($p = 0.034$) following the intervention, with no significant change in Katz scores ($p = 0.174$) (Table 3).

Table 2 - Berg Balance Scale and Lawton IADL Scale scores before and after the intervention

Participant	Berg Balance Scale		Lawton Scale	
	Before	After	Before	After
P1	MFR	MFR	Partial dependence	Independence
P2	MFR	MFR	Partial dependence	Independence
P3	IFR	MFR	Independence	Independence
P4	MFR	MFR	Independence	Independence
P5	IFR	MFR	Partial dependence	Partial dependence
P6	MFR	MFR	Independence	Independence
P7	IFR	MFR	Partial dependence	Partial dependence
P8	MFR	MFR	Independence	Independence
P9	MFR	MFR	Independence	Independence
P10	MFR	MFR	Independence	Independence

Note: IADL = instrumental activities of daily living; MFR = minimal fall risk (score 56-54); IFR = 6 to 8% increase in fall risk (score 56-46). Partial dependence: score > 5 < 21; Independence: score 21.

Table 3 - Wilcoxon test (KATZ, Lawton and Berg scales)

Before intervention	After intervention	Wilcoxon W	p-value
KATZ	KATZ	0.00[a]	0.174
Lawton	Lawton	0.00[b]	0.026
Berg Balance	Berg Balance	0.00[b]	0.034

Note: Ha μ (Pre – Post) ≠ 0; [a]Seven tied pairs; [b]Four tied pairs.

Discussion

This study assessed balance and functional outcomes following neurofunctional physiotherapy interventions in long COVID cases in the Brazilian Amazon. The results indicated statistically significant improvements in both balance and IADLs.

Participants were predominantly women, which is consistent with Oliveira et al.,[24] who reported 57.6% female participants in a study of 59 individuals with post-COVID-19 syndrome in Recife, Brazil, aged 18 to 70 years. By contrast, Ferrarello et al.[25] followed 44 patients with COVID-19 for up to six months after physiotherapy and reported a wider age range (35 - 94 years) than in our study (37 - 64 years).

In the present study, 70% of participants had hypertension and 20% diabetes mellitus, partially aligning with the findings of Tleyjeh et al.[26] in COVID-19 patients at a Saudi Arabian hospital. These authors identified pre-existing hypertension as a strong predictor of new or persistent symptoms, while diabetes mellitus was associated with a reduced likelihood of prolonged symptoms. Although some of these symptoms may be related to long COVID comorbidities, their role remains difficult to determine, since diagnosis can be complex and inconsistent.

Additional comorbidities in this study included unspecified rheumatism (20%), fibromyalgia (20%), and myasthenia gravis (10%). In a large-scale study involving 10,027,506 Korean and 12,218,680 Japanese patients aged 20 years or older, which included individuals with COVID-19, influenza, and noninfected controls, COVID-19 survivors were at greater risk of inflammatory rheumatic diseases than their noninfected counterparts.[27] This aligns with our observations of inflammatory rheumatic diseases in this cohort.

The single participant with myasthenia gravis was noteworthy for the neuromuscular manifestations observed, despite Priyal et al.[28] reporting this condition as rare in COVID-19 patients.

All participants with comorbidities experienced isolated or combined changes in balance or IADLs and improved after the intervention, except one individual with fibromyalgia, who remained partially dependent according to the Lawton Scale. These findings suggest that comorbidities may have affected rehabilitation outcomes in long COVID patients, although the mechanisms underlying their impact on physiotherapy remain unclear.

With respect to ABDLs and IADLs, Rofail et al.[29] found that long COVID patients reported various quality-of-life impacts. In our study, 60% of participants were partially dependent in IADLs at baseline, which decreased to 20% after the physiotherapy intervention, demonstrating its positive effect on functional independence in long COVID patients.

Balance, a key factor in fall prevention and autonomy, can be compromised in long COVID. A previous study of 41 individuals with long COVID found that 22 reported impaired balance and 33 showed deficits on the Sharpened Romberg test.[30] In the present study, targeted physiotherapy led to significant improvements in balance scores ($p = 0.034$).

Several limitations must be acknowledged. The small sample size ($n = 10$) reflected recruitment difficulties, often due to a lack of documented COVID-19 diagnoses, a challenge linked to limited healthcare access in the region and insufficient primary care coverage. Geographic barriers also hindered participation, especially among riverside residents on nearby islands, and limited internet connectivity complicated communication and follow-up. Furthermore, the intervention was not standardized, since eight participants received two weekly sessions while two were treated three times a week, with treatment content varying according to symptoms (e.g. electrotherapy for pain). This variability limits the strength of conclusions. Despite these limitations, given the dearth of research on neurofunctional physiotherapy in long COVID, this study provides valuable preliminary evidence for rehabilitation in this population.

Conclusion

The neurofunctional physiotherapy protocol effectively improved balance and increased independence in IADLs in individuals with long COVID, although no significant gains were observed in BADLs. These findings suggest that neurofunctional physiotherapy can be beneficial for this population. Further clinical research is needed to investigate the effects of neurofunctional physiotherapy on balance and functional capacity after COVID-19. The study also underscores the need for accessible healthcare services in remote regions and interventions to address barriers related to age, sex, and socioeconomic status. Ongoing professional education regarding long COVID treatment is also critical to ensure safe, effective, and evidence-based care.

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Authors' contributions

DFSC, VRG and TBVS designed the study. DFSC, VRG, and BFS were responsible for data collection and DFSC and VRG for data analysis. DFSC, VRG, BFS, TBVS and MLCB developed the methodology. DFSC and VRG drafted the manuscript, which was reviewed by MLCB. DFSC, VRG, NCR and MLCB supervised and reviewed the project and the manuscript. All the authors approved the final manuscript.

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Data Availability Statement

Research data is not available.