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Muscle mass and strength are associated with lower scores of Long COVID symptoms

A massa e a força muscular estão associadas a menor sintomatologia de COVID Longa

La masa muscular y la fuerza están associadas com puntuaciones más bajas de síntomas de COVID Prolongado

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Abstract
Introduction: Long COVID refers to the persistence of symptoms even after acute recovery from COVID-19. However, the association of anthropometric and functional variables with Long COVID symptoms requires clarification. Objective: to correlate body weight, body fat, muscle mass, muscle strength and function with a score of Long COVID symptom's prevalence and severity. Methods: This is a Cross-sectional study. Seventeen adult participants (29.5 ± 7.1 kg/m^2) were submitted to body composition, strength and physical function assessments. They answered a Long Covid symptoms prevalence and severity questionnaire. Variables were correlated and participants were compared using the median of the Long Covid symptoms score. Results: muscle mass percentage (r = -0.52) and biceps muscle thickness (r = -0.54) negatively correlated with the symptoms score (P < .05), while body fat (r = 0.56) and BMI (r = 0.59) correlated positively (P < .05). Participants below the median of the symptoms score presented higher muscle mass (30.5 ± 5.5 vs 23.3 ± 3.9%), thickness (26.3 ± 4.2 vs 21.2 ± 4.2mm), relative strength (1.28 ± 0.3 vs 0.96 ± 0.3 AU) and functional performance *as per* the five times sit-to-stand test (9.7 ± 2.1 vs 12.3 ± 2.4 s), whilst presenting lower body fat percentage (32.0 ± 7.6 vs 45.8 ± 9.4%) and BMI (25.6 ± 4.0 vs 33.1 ± 7.4 kg/m^2) compared to those above the median, respectively. Conclusions: participants who have better body composition, greater strength and physical capacity show a lower prevalence and intensity of Long COVID symptoms.
Keywords: Rehabilitation; Body composition; Post-Acute COVID-19 Syndrome; Muscle strength.

Resumo
Introdução. A COVID longa refere-se à persistência de sintomas mesmo após a recuperação aguda da COVID-19. Contudo, a associação de variáveis antropométricas e funcionais com os sintomas da COVID longa não são claras. Objetivo: correlacionar peso, gordura corporal, massa muscular, força e função com um escore de prevalência e gravidade dos sintomas da COVID longa. Métodos: Estudo transversal. Dezessete participantes adultos (29,5 ± 7,1 kg/m2) foram submetidos a avaliações da composição corporal, força e função física, e responderam um questionário de prevalência e severidade de sintomas. As variáveis foram correlacionadas e os participantes foram comparados usando a mediana do escore de sintomas de Covid longa. Resultados: a percentagem de massa muscular (r = -0,52) e a espessura do bíceps (r = -0,54) correlacionaram-se negativamente com a pontuação dos sintomas, enquanto a gordura corporal (r = 0,56) e o IMC (r = 0,59) se correlacionaram positivamente (P <0,05). Participantes abaixo da mediana da pontuação dos sintomas apresentaram maior massa muscular (30,5 ± 5,5 vs 23,3 ± 3,9%), espessura do bíceps (26,3 ± 4,2 vs 21,2 ± 4,2mm), força relativa (1,28 ± 0,3 vs 0,96 ± 0.3 UA) e desempenho no teste de sentar e levantar (9,7 ± 2,1 vs 12,3 ± 2,4 s), bem como menor gordura corporal (32,0 ± 7,6 vs 45,8 ± 9,4%) e IMC (25,6 ± 4,0 vs 33,1 ± 7,4 kg/m2), respectivamente. Conclusões: os participantes que têm uma melhor composição corporal, maior força e capacidade física apresentam uma menor prevalência e intensidade dos sintomas de COVID longa.
Palavras-chave: Reabilitação; Composição corporal; Síndrome de COVID-19 pós-aguda; Força muscular.

Resumen
Introducción: El COVID prolongado se refiere a la persistencia de síntomas incluso después de la recuperación aguda del COVID-19. Sin embargo, la asociación de variables antropométricas y funcionales con los síntomas del COVID prolongado no está clara. Objetivo: Correlacionar peso, grasa corporal, masa muscular, fuerza y función con un puntaje de prevalencia y gravedad de los síntomas del COVID prolongado. Métodos: Estudio transversal. Diecisiete participantes adultos (29,5 ± 7,1 kg/m²) fueron sometidos a evaluaciones de composición corporal, fuerza y función física, y respondieron un cuestionario sobre prevalencia y gravedad de los síntomas. Las variables fueron correlacionadas y los participantes fueron comparados usando la mediana del puntaje de síntomas de COVID prolongado. Resultados: El porcentaje de masa muscular (r = -0,52) y el grosor del bíceps (r = -0,54) se correlacionaron negativamente con el puntaje de síntomas, mientras que la grasa corporal (r = 0,56) y el IMC (r = 0,59) se correlacionaron positivamente (P < 0,05). Los participantes por debajo de la mediana del puntaje de síntomas presentaron mayor masa muscular (30,5 ± 5,5 vs 23,3 ± 3,9%), grosor del bíceps (26,3 ± 4,2 vs 21,2 ± 4,2 mm), fuerza relativa (1,28 ± 0,3 vs 0,96 ± 0,3 UA) y rendimiento en la prueba de sentarse y levantarse (9,7 ± 2,1 vs 12,3 ± 2,4 s), así como menor grasa corporal (32,0 ± 7,6 vs 45,8 ± 9,4%) e IMC (25,6 ± 4,0 vs 33,1 ± 7,4 kg/m²), respectivamente. Conclusiones: Los participantes con mejor composición corporal, mayor fuerza y capacidad física presentan una menor prevalencia e intensidad de los síntomas de COVID prolongado.
Palabras clave: Rehabilitación; Composición corporal; Síndrome post agudo de COVID-19; Fuerza muscular.

1. Introduction

In December 2019, the COVID-19 pandemic began in the city of Wuhan, China. In the following years, the disease caused by the SARS-CoV-2 virus, from the coronaviridae family, affected a large part of the global population (Organização Pan-Americana da Saúde. Escritório Regional para as Américas, 2025). As of now, according to the World Health Organization (WHO), there have been over 777 million cases worldwide, resulting in the death of 7.1 million people. In Brazil, approximately 39 million cases have been reported, leading to 715 thousand deaths. This data was last updated on February 20, 2025 (World Health Organization, 2025).

Several factors have been associated with worse clinical outcomes of COVID-19, such as the presence of comorbidities, low muscle mass and strength, as well as higher body fat percentage. Beyond the problems caused by the acute infection of the SARS-CoV-2 virus, which include fever, severe respiratory tract inflammation, cough, dyspnea, fatigue, and myalgia, among others, some individuals suffer from symptoms that persist after the infection ends (Bigdelou et al., 2022). According to Wesley Ely and colleagues (2024), the definition chosen by NASEM (*National Academies of Sciences, Engineering and Medicine*) for Long COVID is: “a chronic condition associated with infection after SARS-CoV-2 infection that has symptoms present for at least 3 months continuously, with relapses and remissions, or progressively affecting one or more organs” (Ely et al., 2024). Despite the existence of various terms referring to this condition (such as post-COVID-19 syndrome, post-acute sequelae of COVID-19, etc.), the term chosen in this research was Long COVID.

According to a meta-analysis (Chen et al., 2022), the global prevalence of Long COVID (considering only studies that evaluated symptom persistence between 90 and 120 days after acute infection) is 0.32 (95% CI, .14–.57) for 90 days, and 0.49 (95% CI, .40–.59) for 120 days (Chen et al., 2022). Following the estimate found by the authors and the data reported by the WHO, the number of people with Long COVID now would be approximately between 248 and 380 million worldwide. In Brazil, this number would be approximately between 12 and 19 million people.

Commonly associated symptoms with Long COVID include fatigue, shortness of breath, joint pain, chest pain, among others (Carfì et al., 2020; Davis et al., 2023). Such symptoms impact functionality and reduce quality of life. Currently, the De Paul Symptoms Questionnaire has been a tool used to measure the frequency and intensity of Long COVID symptoms (DeMars et al., 2022; Jason & Dorri, 2023). Notably, these symptoms can persist for years in affected patients and negatively impact their quality of life (Ely et al., 2024).

However, the association of anthropometric and functional variables with Long COVID symptoms still requires clarification. Considering the implications of Long COVID, the present study aimed to correlate anthropometric variables

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(body weight, body fat percentage, and muscle mass), biochemical markers (fasting glucose), blood pressure, and functional variables (sit-to-stand test five times, handgrip strength, timed up and go, 6-minute walk, and bicep thickness) with the results of the Long COVID symptom questionnaire (DSQ-COVID) in adult participants of both sexes.

2. Methodology

This is a cross-sectional study of quantitative nature (Pereira et al., 2018) which used descriptive statistics with mean values, standard deviation, absolute frequency and relative percentage frequency (Shitsuka et al., 2014) as well as used statistical criteria (Vieira, 2021) and, that included men and women over 18 years old, physically inactive for the last six months, non-smokers, and exhibiting symptoms that could be associated with Long COVID for at least three months after the end of the acute infection. Participants were recruited using digital and physical media in two universities. This short paper presents the results of the 17 participants that signed the Informed Consent Form and finished the procedures. The study was approved by the institution's Research Ethics Committee under protocol number: 6.313.134.

Anthropometry variables were body composition (body mass, fat mass and muscle mass percentage) measured using a tetrapolar bioelectrical impedance device (OMRON HBF-510, OMRON Healthcare Inc. Lake Forest, IL), height using a portable ultrasonic stadiometer (Inlab®), and the body mass index (BMI) was calculated by dividing body mass by height squared (kg/m²).

Muscle strength and function variables were handgrip strength following literature recommendation (Reis & Arantes, 2011) and using hydraulic hand dynamometer (SAEHAN), Five Times Sit-to-Stand Test (5TSTS), Timed Up and Go (TUG), and Six-Minute Walk Test (6MWT). The test procedures and classification followed the protocols and guidelines previously described (American Lung Association, [s.d.]; Centers for Disease Control and Prevention, 2017; Melo et al., 2019). Biceps muscle thickness was assessed using a portable A-type ultrasound device (Body Metrix 200). The measurement was performed following all manufacturer recommendations (Abe et al., 2000).

Resting blood pressure (OMRON HEM-7320, OMRON Healthcare Inc. Lake Forest, IL) and fasting blood glucose were also measured. The severity and prevalence of Long Covid symptoms were assessed using the DePaul Symptom Questionnaire – COVID (DSQ-COVID) translated to Portuguese and converted into a digital format. The questionnaire results were calculated according to the method recommended by the DSQ-COVID researchers (Jason & Dorri, 2023). To obtain a single value that could represent all symptoms collectively, the scores of each symptom were summed. This score was used to perform correlations and comparisons.

The Shapiro-Wilk test showed that all variables were normally distributed. The Pearson correlation test was performed with all variables. A significance level of $P < 0.05$ was adopted Subsequently, participants were divided into two groups based on the median of each dependent variable for comparison. Another Shapiro-Wilk test was conducted to verify normality, with height, body fat, and body mass percentage being non-parametric but with homogeneity of variances (Levene's test). A Student's T-test for independent samples was then conducted to compare volunteers above and below the median.

3. Results

The sample consisted of 17 adults (13 females). Table 1 presents the descriptive characteristics of the participants. According to BMI, blood pressure, and blood glucose levels, the sample is classified as overweight but normotensive and non-diabetic.

Table 1 - Descriptive characteristics of the sample (n = 17).

Variable	**Mean**	**SD**
Age (years)	43.1	15.7
Height (cm)	164.1	7.3
Body mass (kg)	80.5	17.6
BMI (kg/m^2)	29.5	7.1
Body fat (%)	39.3	11.0
Muscle mass (%)	26.7	5.9
Biceps thickness (mm)	23.6	4.8
SBP (mmHg)	122.2	14.7
DBP (mmHg)	83.8	9.5
Glucose (mg/dl)	90.0	9.6
5TSTS (s)	11.1	2.5
TUG (s)	8.8	2.0
6MWT (m)	445.6	85.7
HGS (kgf)	31.6	8.1
HGS/BMI (AU)	1.1	0.3
DSQ Score (AU)	1532.2	522.1

Notes: AU: arbitrary unit, SD: standard deviation, BMI: body mass index, SBP: systolic blood pressure, DBP: diastolic blood pressure, 5TSTS: five times sit-to-stand test, TUG: timed-up and go, 6MWT: six minutes' walk test, HGS: hand grip strength, DSQ: de Paul Symptoms questionnaire. Source: Research data (2025).

Figure 1 shows the main significant correlation between the variables and the DSQ score. Body mass, body fat percentage, BMI (all positively), and muscle mass percentage (negatively) were significantly correlated with the DSQ score ($P < .05$). Additionally, biceps brachii muscle thickness was negatively correlated with the DSQ score ($r = -0.54$, $p = 0.023$). No significant correlations were observed between the other variables and the DSQ.

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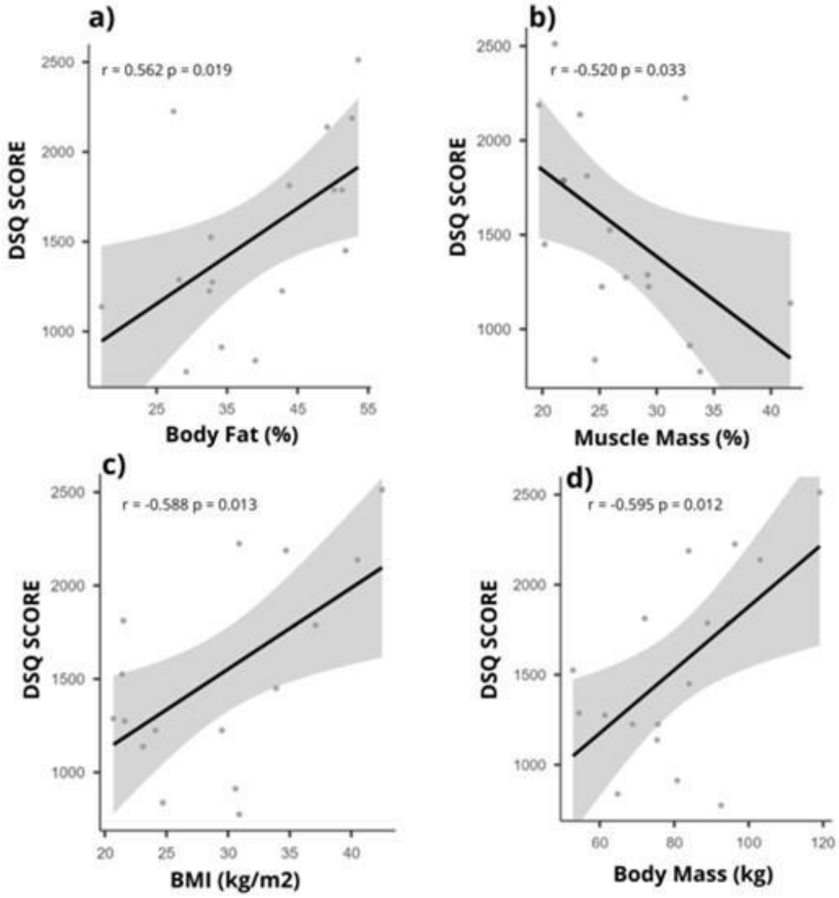
Figure 1 - Significant correlations with DSQ score (Pearson correlation coefficients).



Notes: a) % body fat and DSQ. b) % muscle mass and DSQ. c) BMI and DSQ. d) Body mass and DSQ. Source: Research data (2025).

The median score of the DSQ-COVID test was calculated, resulting in 1450.0 (25th percentile = 1225.0 and 75th percentile = 1812.5). For comparison purposes, the sample was divided into those above (n = 9) and below the median (n = 8). Participants above the median, meaning those with a higher frequency and intensity of symptoms, had greater total body mass, BMI, body fat percentage, and longer time to complete the 5TSTS test. They also exhibited a lower muscle mass percentage and thinner biceps brachii muscle, as shown in Table 2.

According to BMI, participants above DSQ median score were obese, while participants below the median were overweighed. Blood pressure, glucose, TUG, HGS, 6MW, and age did not differ between groups.

Table 2 - Comparison between groups above and below the median DSQ-COVID score. Values are presented as mean ± standard deviation.

Variable	Group (median DSQ score)		*P*	ES
	Above (n=9)	Below (n=8)		
Age (years)	45.7 ± 14.5	40.1 ± 17.4	0.47	0.35
Body mass (kg)	88.3 ± 18.8	71.7 ± 12.0	**0.05**	**1.0**
Height (cm)	161.2 ± 6.6	167.3 ± 6.9	0.08	0.89
BMI (kg/m^2)	33.1 ± 7.4	25.6 ± 4.0	**0.024**	**1.21**
Body fat (%)	45.8 ± 9.4	32.0 ± 7.6	**0.005**	**1.59**
Muscle mass (%)	23.3 ± 3.9	30.5 ± 5.5	**0.008**	**1.49**
Biceps thickness (mm)	21.2 ± 4.2	26.3 ± 4.2	**0.024**	**1.22**
SBP (mmHg)	116.7 ± 12.2	128.3 ± 15.6	0.105	**0.83**
DBP (mmHg)	83.0 ± 9.1	84.6 ± 10.5	0.747	0.15
Glucose (mg/dl)	89.0 ± 10.0	91.1 ± 9.5	0.663	0.21
5TSTS (s)	12.3 ± 2.4	9.7 ± 2.1	**0.033**	**1.14**
TUG (s)	8.8 ± 1.7	8.8 ± 2.3	0.928	0.04
6MW (m)	446.0 ± 70.1	445.2 ± 105.7	0.986	0.008
HGS (kgf)	30.7 ± 8.4	32.6 ± 8.1	0.654	0.22
HGS/BMI (AU)	0.96 ± 0.3	1.28 ± 0.3	0.059	**0.99**

Notes: AU: arbitrary unit SD: standard deviation, ES: effect size, BMI: body mass index, SBP: systolic blood pressure, DBP: diastolic blood pressure, 5TSTS: five times sit-to-stand test, TUG: timed-up and go, 6MWT: six minutes' walk test, HGS: hand grip strength, DSQ: de Paul Symptoms questionnaire. Source: Research data (2025).

4. Discussion

The aim of this study was to correlate anthropometric data and functional tests with the DSQ-COVID score. The variables Body mass, body fat percentage and BMI were found to be positively correlated with the DSQ-COVID score, while muscle mass percentage and biceps brachii thickness were negatively correlated with the symptom score. These findings confirm the hypothesis that body composition affects the prevalence and intensity of long COVID symptoms.

Considering Pearson's correlation coefficients, it was found that higher values of body weight, body fat percentage and BMI are related to worse reports of long COVID symptoms, while higher values of muscle mass and biceps muscle thickness indicate lower prevalence and severity of symptoms. These findings are in line with literature. According to Tziolos et al (Tziolos et al., 2023) a high BMI is considered a risk factor for the development of Long COVID. It is worth noting that the sample in this study can be classified as overweight, given their average BMI of around 29 kg/m2. The link between excess body fat and the worsening of COVID-19 symptoms, i.e. during the acute phase of the infection, has also been widely demonstrated (Silva et al., 2021).

On the other hand, previous evidence has shown that patients with more muscle mass and strength recover faster from acute Covid-19 infection (Gil et al., 2021). In the present study, both the percentage of muscle mass and the thickness of the biceps brachii correlated negatively with the symptom score, indicating that the potential protective effect exerted by muscle tissue during acute Covid-19 infection is maintained in Long Covid.

The associations found in the correlation analysis became even more evident when comparisons were made between participants who were above or below the median DSQ-COVID score. As shown in Table 2, individuals with symptom scores above the median had higher total body mass, BMI, body fat percentage and longer time to complete the 5TSTS test. On the other hand, individuals below the median had a higher percentage of muscle mass and greater biceps brachii thickness. Interestingly, despite not reaching statistical significance ($p = 0.059$), but with a large effect size (0.99), individuals below the median had greater relative handgrip strength, i.e. handgrip strength divided by BMI. The HGS/BMI ratio is important because it considers differences in body size that can influence the result of handgrip strength (Almeida et al., 2022).

In this sense, the comparison between the groups showed that the group above the median had a worse body composition, being classified as obese given their BMI above 30 kg/m2, as well as less relative muscle strength and lower functional capacity (worse result in the 5TSTS), when compared to the group that was below the median. Kirwan and colleagues (Kirwan et al., 2020) reported that a decrease in muscle mass is associated with a greater increase in mortality from Covid-19, which can be further increased by increasing body fat, whereas lower mortality rates were associated with people who have more muscle mass. In addition, not only muscle mass, but also muscle strength positively interferes with recovery from Covid-19. In the present study, we found that such changes in body composition, strength and functionality continue to be important factors in the prevalence and severity of symptoms post-covid.

Regarding the functional tests, the 5TSTS, the only test that showed a significant difference between the two groups, is also the only test that the participants were instructed to perform as quickly as possible, and the other tests were performed at their usual walking speed. Bearing in mind that one of the most prevalent symptoms in the questionnaire was fatigue and tiredness, it may be that the participants in the group above the median showed a worse result because it was the test that required the most effort. It is worth noting that the symptom of fatigue is a symptom commonly associated with Long COVID (Salari et al., 2022) and can have devastating effects on the lives of people affected by the condition. In the questionnaire, all the participants in this study reported fatigue.

The limitation of this study lies in the sample. It was a convenience sample of only 17 participants, 13 of whom were women and 4 men. Therefore, the statistical power and the ability to extrapolate the results are reduced. However, to the best of our knowledge, this is the first study to use a translated version of the DSQ-COVID in Portuguese and to correlate the DSQ-COVID score with anthropometric variables and functional tests in the population, showing the innovative nature of the study. In addition, the results may be of clinical relevance and could help with Long COVID rehabilitation strategies.

5. Final Considerations

In view of the present results, it can be concluded that participants who have a better body composition, greater strength and physical capacity show a lower prevalence and intensity of Long COVID symptoms. In other words, maintaining an adequate body composition, with more muscle mass and less body fat, as well as maintaining strength and physical capacity can bring benefits with regards to the prevalence and intensity of Long COVID symptoms. Thus, strategies to optimize body composition, strength and functional capacity are important in the context of rehabilitation and improving the quality of life of people with Long COVID. Future studies are needed with larger samples to elucidate the relationship between these variables and Long COVID symptoms and, potentially, to generate predictive models of Long COVID symptoms based on muscle mass, strength, and body fat.

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