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Evaluation of Sarcopenia in COVID-19 Survivors: A Common But Overlooked Problem

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ABSTRACT

Objective: In patients with COVID-19, the possibility of sarcopenia has climbed further by adding inflammation, malnutrition, and physical inactivity to pre-existing health conditions. This study aimed to examine the sarcopenia status and related factors of patients diagnosed with COVID-19 in the near term after discharge.
Methods: Patients hospitalized due to COVID-19 were included in this cross-sectional study on the 14th day after discharge. Examinations of the patients were performed in the post-COVID-19 follow-up outpatient clinic and then comprehensive assessments were made in the geriatric medicine outpatient clinic. Anthropometric measurements, handgrip strength, muscle mass assessment by ultrasonography, and bioelectrical impedance analysis were performed. Grip strength cut-offs were taken as 16 kg for females and 27 kg for males, and those lower than these values were accepted as having probable sarcopenia.
Results: In total, 49 patients participated and their mean age was 59.0 ± 12.4 years, while the ratio of female participants was 53.1% (n = 26). Of the patients, 49.0% (n = 24) had multimorbidity. There were 17 (34.7%) probable sarcopenic patients. In bioelectrical impedance analysis measurements, the fat ratio was higher ($P < .05$), and appendicular skeletal muscle index was lower in probable sarcopenic patients ($P < .001$). In ultrasonography measurements, gastrocnemius muscle thickness, gastrocnemius fascicle length, rectus femoris muscle thickness, and rectus femoris cross-sectional area were lower in probable sarcopenic patients ($P < .05$ for all), but there was no difference in trunk muscles ($P > .05$). Among anthropometric measurements, mid-arm and calf circumferences were lower in probable sarcopenic patients ($P < .05$ for all). In regression analysis, as a result of the model created, multimorbidity was associated with probable sarcopenia (odds ratio: 3.9, 95% CI: 1.06-14.30, $P = .04$).
Conclusion: The possibility of sarcopenia increases in patients with COVID-19, especially the group with multimorbidity should be evaluated in terms of sarcopenia to prevent adverse health outcomes related to sarcopenia. Handgrip strength, bioelectrical impedance analysis, ultrasonography, and anthropometric measurements can be used in the evaluation of sarcopenia.

Keywords: COVID-19, malnutrition, sarcopenia

INTRODUCTION

Sarcopenia is a syndrome with decreased muscle mass, strength, and function.[1] It increases the risk of adverse health outcomes such as dysphagia, falls, fractures, functional decline, frailty, hospital admissions, morbidity, and mortality.[2,3] There are many causes of sarcopenia, such as low protein and energy intake, malabsorption, cancer, neurological diseases, joint and muscle diseases, diabetes, chronic obstructive lung disease, sedentary lifestyle, immobilization, hospital admission, drugs, and cachexia.[4]

COVID-19 caused a pandemic that resulted in nearly 6.5 million deaths over the last 3 years. In addition to mild to severe inflammatory response, quarantine processes, curfews, social isolation, and stress increased the risk of sarcopenia. Increased sarcopenia risk was also related to inflammation, malnutrition, physical inactivity, and pre-existing diseases.[5,6] COVID-19 patients with sarcopenia showed higher prevalences of frailty and mortality.[7] The mean time required for the development of sarcopenia varies according to the severity and duration of the disease. Sarcopenia can occur at any stage of the disease, acute or post-COVID-19 processes.[5,8]

Due to the isolation during the pandemic, it is difficult to evaluate sarcopenia. The European Working Group on Sarcopenia in Older People (EWGSOP) recommends the

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measurement of muscle strength with handgrip, and low muscle strength is related to probable sarcopenia (PS).[2] Therefore, the aim of this study was to examine the PS and related factors of patients with COVID-19 after hospital discharge.

METHODS

Participants

This cross-sectional study included 49 patients hospitalized with COVID-19. Patients were evaluated on the 14th day of the hospital discharge in post-COVID follow-up outpatient clinic. Comprehensive assessments were performed in the geriatrics outpatient clinic of hospital. Age, sex, education and marital status, hospitalization clinical follow-up, chronic diseases, medications, activities of daily living, nutritional status, frailty status, anthropometric measurements, and laboratory examinations of the patients were recorded.

Inclusion criteria for the study were given as follows:

1. hospitalization with COVID-19 infection and
2. being able to cooperate with tests.

Exclusion criteria for the study were given as follows:

1. not being able to cooperate with the tests,
2. hemodialysis/peritoneal dialysis patients,
3. presence of severe edema in the lower extremities (grade 3 and 4 pretibial edema),
4. having severe dehydration (hypovolemic symptoms like decline in consciousness, tachycardia, low blood pressure, peripheral cyanosis, oligouria, etc.),
5. uncontrolled hypothyroidism or hyperthyroidism,
6. having a cardiac pacemaker or implant,
7. history of amputation in extremities,
8. inflammatory rheumatic diseases (independent from disease activity),
9. systemic atrophies that mainly affect the central nervous system such as Huntington's disease, hereditary ataxia, spinal muscular atrophy and related syndromes, postpolio syndrome,
10. demyelinating diseases of the central nervous system,
11. oral corticosteroids (≥ 5 mg/day for >3 months), and
12. history of ischemic/hemorrhagic stroke after COVID-19 infection.

Main Points

- COVID-19 increases the risk of sarcopenia.
- There are several ways to evaluate muscle mass.
- Sarcopenia assessment remains in the background in COVID-19 patients.
- In multimorbid COVID-19 patients, health professionals should be alert for the development of sarcopenia.

Comprehensive Assessment

All patients were evaluated comprehensively. The independence status of the patients was evaluated using the Katz Index of Independence in activities of daily living (ADL)[9] and the Lawton–Brody instrumental ADL (IADL).[10] Katz ADL has 6 items: feeding, continence, transferring, dressing, toileting, and bathing. Lawton–Brody IADL includes the following items: ability to use a telephone, shopping, food preparation, housekeeping, laundry, transportation method, medication use, and handling finances. Katz ADL and Lawton–Brody were both validated for older adults. However, they were used in studies including young populations.[11,12] Nutritional status was assessed using the mini nutritional assessment-short form (MNA-SF).[13] In this test, which is evaluated out of 14 points, 7 points and below are considered malnutrition, between 8 and 11 points are considered malnutrition risk, and 12 points and above are considered normal. Muscle strength was measured by grip strength measurement. A calibrated hand-held dynamometer (T.K.K.5401; Takei Scientific Instruments, Tokyo, Japan) was used. Grip strength was measured 3 times with a dynamometer while the arms of the patients were parallel to the floor. The highest of these 3 values was included in the analysis. Grip strength cut-offs were taken as 16 kg for females and 27 kg for males.[2] Values lower than those cut-offs were considered significant for PS. Gait speed was measured using a digital watch with patients walking 4 m at their usual speed. Gait speed ≤ 0.8 m/s indicates low physical performance.[2] Multimorbidity has been accepted as the coexistence of 2 or more chronic diseases.[14] Frailty assessment was made using the Clinical Frailty Scale, scored from 1 to 9. While 1,2, and 3 points are not considered frail, after the update made in 2020, those who score 4 points and above are considered living with frailty.[15] It was validated for older people but was also used for young adults in studies.[16]

Anthropometric Measurements

Weight and height were measured without shoes while wearing light clothing. Waist circumference was measured from the umbilicus level with the help of a tape, while hip circumference was measured from the widest part of the buttocks. The mid-arm circumference was measured from the midpoint of the acromial and olecranon protrusions while the arm was twisted by 90° from the elbow. Calf circumference was measured from the widest part of the calf while the foot was pressing on a hard surface.

Ultrasonographic Assessment

Ultrasound is a valid and reliable imaging method for evaluating muscle thickness.[17] Measurements were performed using an 8-10 MHz linear probe of 5 cm width (LOG˙IQ 200 PRO, General Electric Medical Systems). Measurements were made from the right side of the body, applying minimal pressure with the US probe. Rectus femoris muscle thickness (MT), rectus femoris cross-sectional area (CSA), gastrocnemius MT, gastrocnemius (GC) pennate angle, GC fascicle length, rectus abdominis MT, internal oblique MT, external oblique MT, and transverse abdominis MT were measured according to the recommendations.[18,19] Images of trunk muscles were taken at the end of expiration to reduce the effect of respiration.[20] The greatest distance between superficial and deep fascia on transverse images was captured for muscle thicknesses. For the pennate angle, the angle between the muscle fibers and the deep fascia was measured in the longitudinal image. The length between the fascicle insertion points to the superficial and deep aponeuroses was measured for fascicle length. Rectus femoris cross-sectional area was defined as the area of the cross-section of a muscle perpendicular to its longitudinal axis. Ultrasound measurements were performed by specialist physicians working in the geriatric polyclinic, which also has a certificate.

Assessment by Bioelectrical Impedance Analysis

The bioelectrical impedance analyses of the patients included in the study were performed using the Body Stat Quadscan 4000 bioimpedance analyzer (BodyStat Ltd, Douglas, Isle of Man, British Isles). There are several factors that affect BIA measurements.[21,22] These factors are noted in the "inclusion and exclusion criteria" section, and patients with one of these were excluded from the study. Measurements were performed after overnight fasting using the multifrequency tetrapolar technique while the patients were lying supine. The appendicular skeletal muscle mass index (ASMI) was calculated. The following equation, suggested by Kyle et al[23], was used to determine the appendicular skeletal muscle mass (ASM): $4.211+0.267 \times \text{height}^2/\text{resistance}+0.95 \times \text{weight}+1.999 \times \text{sex (males}=1\text{, females}=0)+-0.012 \times \text{age}+0.058 \times \text{reactance}$. The ASMI was calculated and corrected for height^2. An ASMI below 7.0 kg/m^2 for males and 5.5 kg/m^2 for females was accepted as low muscle mass.[2]

Ethical Approval

The study was approved by the Hacettepe University Faculty of Medicine Non-interventional Clinical Research Ethics Board (Date: May 21, 2021, Decision No: 2021/11-31). It was performed in compliance with the Declaration of Helsinki.

Statistical Analysis

Statistical analysis was wielded using Statistical Package for the Social Sciences version 24.0 (IBM Corp, Armonk, NY, USA). While descriptive statistics were presented, mean, standard deviation, median, and interquartile range were used according to the normal distribution status for numerical values. In contrast, numbers and percentages were used for categorical variables. In comparing numerical values, Student's *t*-test or Mann–Whitney *U* test was used according to normal distribution. Chi-square or Fisher exact tests were performed to compare categorical variables. For correlations, the Spearman rho test was employed. Logistic regression analysis was performed to determine the parameters that independently affect PS. A *P*-value <.05 was accepted as statistically significant.

RESULTS

This study included 49 patients and their mean age was 59.0 ± 12.4 years, while the ratio of female participants was 53.1% (n=26). Forty-nine percent (n=24) of the patients had multimorbidity. Twenty-three (46.9%) patients had used 5 or more drugs daily. The median hospital stay was 11.0 days (interquartile range (IQR): 7.0), while 46.9% (n=23) of the patients stayed in the intensive care unit. The ratio of patients given steroid treatment because of COVID-19 was 61.2% (n=30). The median CFS score was 3.0 (IQR: 1.0). There were 9 (18.4%) patients with slow gait speed. The main demographic and clinical characteristics of patients are given in Table 1. There were 17 (34.7%) PS patients. According to age and sex, there was no difference. Probable sarcopenia was more common in patients with multimorbidity and frailty (Table 1).

The median MNA-SF score was 9.0 (IQR: 2.0). There was a risk of malnutrition according to MNA-SF in 83.7% of the patients. Six (12.2%) patients were malnourished. Although the probability of PS was high in malnourished patients, this was not statistically significant (*P*=.16) (Table 1). Four (8.2%) patients were discharged with oral nutrition supplement therapy.

In anthropometric measurements, mid-arm and calf circumferences were lower in the PS group (*P*=.001, *P*=.03, respectively). There was no difference between the groups in other anthropometric measurements (Table 2). None of the anthropometric measurements correlated with grip strength (Table 3).

In BIA measurements, the fat ratio was higher and ASMI was lower in PS patients. In ultrasonographic measurements, GC MT, GC fascicle length, RF MT, and RF CSA were lower in PS patients, but there was no difference in trunk muscles. Among anthropometric measurements,

Table 1. Demographic and Clinical Characteristics of Patients

Characteristics	Total (n=49) (n, %)	Probable Sarcopenia (n=17, 34.7%) (n, %)	Non-Sarcopenia (n=32, 65.3%) (n, %)	*P*
Age (years) (mean ± SD)	59.0 ± 12.4	62.4 ± 8.7	57.2 ± 13.8	.17
Sex (female)	26 (53.1)	12 (70.6)	14 (43.8)	.07
Education (≤5 years)	20 (40.8)	9 (52.9)	11 (34.4)	.21
Marital status (married)	39 (79.6)	15 (88.2)	24 (75.0)	.46
Smoking	12 (24.5)	2 (11.8)	10 (31.3)	.17
Multimorbidity	24 (49.0)	12 (70.6)	12 (37.5)	.03
Drug number (median, IQR)	4.0 (5.0)	6.0 (7.0)	3.0 (6.0)	.09
Polypharmacy (≥5 drugs)	23 (46.9)	11 (64.7)	12 (37.5)	.07
Steroid	30 (61.2)	9 (52.9)	21 (65.6)	.39
Length of hospital stay (median, IQR)	11.0 (7.0)	12.0 (11.5)	10.0 (5.8)	.24
Intensive care unit admission	23 (46.9)	10 (58.8)	13 (40.6)	.22
Katz ADL (median, IQR)	6.0 (0.0)	6.0 (0.0)	6.0 (0.0)	.45
Lawton–Brody IADL (median, IQR)	8.0 (0.0)	8.0 (1.0)	8.0 (0.0)	.003
MNA-SF (median, IQR)	9.0 (2.0)	9.0 (2.0)	9.0 (2.0)	.82
MNA-SF (≤7 points)	6 (12.2)	4 (23.5)	2 (6.3)	.16
CFS (median, IQR)	3.0 (1.0)	4.0 (1.5)	3.0 (2.0)	.01
CFS (≥4 points)	22 (44.9)	11 (64.7)	11 (34.4)	.04
Gait speed (<0.8 m/s)	9 (18.4)	7 (41.2)	2 (6.3)	.003
Hemoglobin (g/dL) (mean ± SD)	13.1 ± 1.8	12.5 ± 1.9	13.4±1.6	.13
Leukocyte (×10^3/μL) (mean ± SD)	6.6 ± 1.8	6.3 ± 1.7	6.8 ± 1.8	.41
Albumin (g/dL) (mean ± SD)	4.0 ± 0.4	3.8 ± 0.4	4.0 ± 0.4	.53
C-reactive protein (mg/dL) (median, IQR)	0.64 (0.82)	0.81 (0.92)	1.04 (0.62)	.68

ADL, activities of daily living; CFS, Clinical Frailty Scale; IADL, instrumental activities of daily living; IQR, interquartile range; MNA-SF, mininutritional assessment-short form; n, number; SD, Standard deviation.

mid-arm and calf circumferences were lower in PS patients (Table 2). Sarcopenia diagnosis was confirmed by BIA in only 6 (12.2%) patients.

Fat ratio, age, CFS score, and gait speed were negatively correlated with grip strength, while ASMI, GC MT, RF MT, RF CSA, RA MT, and EO MT were positively correlated. The strongest negative correlation was in the fat ratio ($r=-0.67$). The strongest positive correlations were in the measurements made from the RF muscle (RF MT $r=0.52$, RF CSA $r=0.53$) (Table 3).

In regression analysis, as a result of the model created, multimorbidity was associated with PS (OR: 3.9, 95% CI: 1.06-14.30, $P=.04$) (Table 4).

DISCUSSION

In the present study, PS in COVID-19 patients was evaluated after hospital discharge. It is important because it was performed in the first weeks of the recovery period after suffering from COVID-19. In this study, which included patients from all age groups, the PS rate was 34.7%. Multimorbidity was independently related to PS.

Although sarcopenia occurs at the end of multiple chronic pathophysiological changes, acute medical disorders can accelerate the development of sarcopenia. The risk of sarcopenia increases in hospitalized patients.[24] COVID-19 accelerates the development of sarcopenia as it causes acute inflammation and is related to hospitalization. In a multicenter study conducted with 407 patients, 73% of the patients hospitalized for COVID-19 were at high risk for sarcopenia.[25] Decreased muscle strength and physical performance had occurred in hospitalized patients due to COVID-19 pneumonia.[26] In our study, decreased grip strength was found in 34.7% of the patients. Appropriate interventions such as nutritional support and exercise can prevent adverse health outcomes in patients with decreased grip strength in COVID-19 patients. However, few COVID-19 patients receive nutritional therapy during recovery.[25] In our study, only 4 (8.2%) patients were discharged with oral nutrition supplement therapy.

Increased unmet needs, healthcare use, sick days, and a decline in perceived health status and quality of life are all linked to multimorbidity.[27] Sarcopenia is more prevalent in those with multimorbidity, and patients with multimorbidity are at increased risk of sarcopenia.[28] Multimorbidity is also a significant problem affecting the course of COVID-19 patients, and COVID-19 patients with comorbidities have a higher mortality risk.[29] There are only few studies about the relationship between sarcopenia and multimorbidity in COVID-19 patients, and more evidence

Table 2. Muscle Mass Assessments by Different Methods

Characteristics	Total (n=49) (n,%)	Probable Sarcopenia (n=17) (n,%)	Non-Sarcopenia (n=32) (n,%)	*P*
BIA assessment				
Fat (%) (mean, SD)	34.9 ± 12.2	40.3 ± 7.1	32.3 ± 13.2	.01
ASMI (kg/m^2) (median, IQR)				
Females	6.3 (5.0-8.7)	5.8 (4.8-7.7)	6.7 (5.9-9.0)	<.001
Males	8.5 (7.9-11.0)	7.6 (7.1-10.2)	8.9 (8.2-10.9)	<.001
Ultrasonographic assessment				
GC muscle thickness, mm (mean, SD)	15.6 ± 3.1	14.4 ± 3.3	16.2 ± 2.8	.04
GC fascicle length, mm (mean, SD)	28.3 ± 5.2	26.2 ± 4.8	29.4 ± 5.1	.03
GC pennate angle, (°) (median, IQR)	28.0 (6.5)	28.0 (6.5)	28.5 (7.0)	.14
RF muscle thickness, mm (mean, SD)	15.8 ± 3.6	13.8 ± 3.2	16.9 ± 3.4	.003
RF cross-sectional area, mm^2 (mean, SD)	7.29 ± 2.7	6.0 ± 2.1	8.0 ± 2.8	.02
RA muscle thickness, mm (median, IQR)	8.0 (3.4)	7.2 (2.1)	8.5 (3.0)	.10
EO muscle thickness, mm (mean, SD)	3.9 ± 1.0	3.6 ± 0.9	4.0 ± 1.1	.21
IO muscle thickness, mm (median, IQR)	5.8 (1.8)	5.5±1.3	6.5±2.0	.07
TA muscle thickness, mm (median, IQR)	3.8 (1.7)	3.7±1.0	4.0±1.1	.36
Anthropometric assessment				
Mid-arm circumference, cm (mean, SD)	29.0 ± 3.9	26.2 ± 3.5	30.3 ± 3.4	.001
Calf circumference, cm (median, IQR)	36.0 (8.0)	33.5±4.3	36.8±4.6	.03
Waist circumference, cm (mean, SD)	96.8 ± 12.2	92.5 ± 12.4	98.0 ± 11.7	.37
Hip circumference, cm (mean, SD)	104.6 ± 10.9	101.7 ± 10.0	105.8 ± 10.3	.27
Waist/hip ratio (median, IQR)	0.92 (0.14)	0.93 (0.21)	0.92 (0.13)	.70
Body mass index (kg/m^2) (mean, SD)	29.5 ± 5.6	27.8 ± 4.4	30.4 ± 6.0	.33

ADL, activities of daily living; CFS, Clinical Frailty Scale; IADL, instrumental activities of daily living; IQR, interquartile range; MNA-SF, mininutritional assessment-short form; n, number; SD, Standard deviation.

is needed with further studies. Our data showed that multimorbidity increased the risk of PS independent of other variables. It is crucial that patients with multimorbidity who have had COVID-19 should also be evaluated regarding sarcopenia.

Bioelectrical impedance analysis is one of the reference methods used to evaluate sarcopenia. As ASMI obtained after BIA measurement indicates skeletal muscle mass, it is part of the algorithm for diagnosing sarcopenia.[2] In addition, the increased fat rate is one of the indirect indicators of the decrease in muscle mass.[22] In our study, the fat ratio and the ASMI measured by BIA were correlated to the grip strength. It will be appropriate to evaluate sarcopenia in patients with COVID-19 with BIA, which is easy to perform.

An increasingly used technique to measure muscle mass in recent years is muscle ultrasonography. Evidence regarding the validity and reliability of ultrasound in demonstrating muscle mass is accumulating, despite the fact that it has not yet been included in the European Working Group on Sarcopenia in Older People (EGSWOP) guidelines. Although there are various publications about which muscle should be taken as a reference in muscle mass measurements performed with ultrasound, and what the

Table 3. Correlation Between Grip Strength and Other Characteristics

Characteristics	Grip Strength Correlation Coefficient	Grip Strength *P*
BIA assessment		
Fat (%)	–0.67	<.001
ASMI	0.58	<.001
Ultrasonographic assessment		
GC muscle thickness	0.42	.003
GC fascicle length	0.25	.09
GC pennate angle	0.19	.19
RF muscle thickness	0.52	<.001
RF cross-sectional area	0.53	<.001
RA muscle thickness	0.46	.001
EO muscle thickness	0.35	.01
IO muscle thickness	0.27	.06
TA muscle thickness	0.11	.44
Anthropometric assessment		
Mid-arm circumference	0.15	.30
Calf circumference	0.06	.67
Waist circumference	–0.07	.64
Hip circumference	–0.22	.13
Waist/hip ratio	0.01	.98
Body mass index	–0.16	.28
Other parameters		
Age	–0.35	.01
Drug number	–0.26	.07
CFS	–0.56	<.001
Gait speed	–0.66	<.001

ASMI, appendicular skeletal muscle index; CFS, Clinical Frailty Scale; EO, external abdominal oblique; GC, gastrocnemius; IO, internal abdominal oblique; RA, rectus abdominis; RF, rectus femoris; TA, transverse abdominis.

cut-off values should be for the diagnosis of sarcopenia, a consensus has not been reached yet.[30,31] In the present study, GC MT and GC fascicle length, RF MT, and RF-CSA were found to be significantly lower in the PS group. There was no difference in the thickness of the abdominal muscles. Measurements from the lower extremity were

Table 4. Regression Analysis of Factors Affecting Probable Sarcopenia

Characteristics	OR	95% CI	*P*
Sex	3.0	0.80-11.09	.10
Multimorbidity	3.9	1.06-14.30	.04

Model: age, sex, ICU stay, length of hospitalization, multimorbidity, polypharmacy, Clinical Frailty Scale.
ICU, intensive care unit; OR, odds ratio.

similar to other studies in the literature.[32] Unlike the literature, no difference was found in the measurements of abdominal muscles. This may be because young patients were included in the study. On the other hand, there was a correlation between the abdominal muscles and handgrip strength in sarcoidosis patients with a mean age of 53.2 years.[16]

In the present study, RF MT and RF CSA measurements were correlated with grip strength. In the study conducted with COVID-19 patients hospitalized in the intensive care unit due to acute respiratory distress syndrome, the RF MT decreased in the follow-up.[33] In another study conducted on intensive care patients, RF MT and RF CSA were decreased.[34] There was also a decline in quadriceps muscle strength in patients with mild to moderate COVID-19.[35] Based on these data, *RF muscle mass measurements* can also be used to evaluate sarcopenia in COVID-19 patients.

Calf circumference is one of the anthropometric measurements used to diagnose sarcopenia and can be used to show muscle mass.[36,37] Another anthropometric measurement that can evaluate sarcopenia is the mid-arm circumference.[38] It successfully demonstrates sarcopenia in various disease groups.[39,40] Our results showed that calf and mid-arm circumferences in COVID-19 patients differed between PS and non-sarcopenic patients. These 2 anthropometric measurements should be kept in mind for evaluating sarcopenia in health centers where there are no devices that can evaluate muscle mass and strength.

Our study has several limitations. First, it is a single-center, cross-sectional study. The number of patients is relatively low, and this might change the statistical significance of some analysis between sarcopenia and other variables such as age, gender, polypharmacy, and so on. Second, the sarcopenia status of the patients before they had COVID-19 is unknown. Third, the cut-off values used to evaluate PS are the values determined to be used in older adults, but our study has patients of different age groups. These cut-off values may have caused the underdetection of PS in patients younger than 65 years.

As a result, the possibility of sarcopenia increases in patients with COVID-19, especially the group with multimorbidity should be evaluated in terms of sarcopenia to prevent adverse health outcomes related to sarcopenia.

Ethics Committee Approval: Ethical committee approval was received from the Ethics Committee of Hacettepe University (Date: May 21, 2021, Decision No: 2021/11-31).

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