Low Thoracic Skeletal Muscle Area Is Not Associated With Negative Outcomes in Patients With COVID-19

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Objective: Sarcopenia has been related to negative outcomes in different clinical scenarios from critical illness to chronic conditions. The aim of this study was to verify whether there was an association between low skeletal muscle index and in-hospital mortality, intensive care unit admission, and invasive mechanical ventilation need in hospitalized patients with COVID-19.

Design: This was a retrospective cohort study of a referral center for COVID-19. We included all consecutive patients admitted to the hospital between February 26 and May 15, 2020, with a confirmed diagnosis of COVID-19. Skeletal muscle index was assessed from a transverse computed tomography image at the level of twelfth thoracic vertebra with National Institutes of Health ImageJ software, and statistical analysis was performed to find an association between skeletal muscle index and in-hospital mortality, need of invasive mechanical ventilation, and intensive care unit admission.

Results: We included 519 patients, the median age was 51 (42–61) yrs, and 115 patients (22%) had low skeletal muscle index. On multivariable analysis, skeletal muscle index was not associated with mortality, intensive care unit admission, or invasive mechanical ventilation need nor in a subanalysis of patients 65 yrs or older.

Conclusions: Skeletal muscle index determined by computed tomography at the level of twelfth thoracic vertebra was not associated with negative outcomes in hospitalized patients with COVID-19.

Key Words: Sarcopenia, COVID-19, Critically Ill, Mortality, Intensive Care Unit, Mechanical Ventilation

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What Is Known

- Decreased skeletal muscle has been related to increased mortality, length of stay, mechanical ventilation need, and difficult weaning among critically ill patients. Frailty, a larger construct commonly linked with sarcopenia, has been already identified as a negative prognostic factor in patients with COVID-19.

What Is New

- Low skeletal muscle index determined by computed tomography at the level of twelfth thoracic vertebra was not associated with mortality, intensive care unit admission, or invasive mechanical ventilation need in hospitalized patients with COVID-19.

Determining prognostic factors for adverse outcomes of inpatients with coronavirus disease (COVID-19) is essential for the creation of prompt strategies to modify the course of the disease. The following characteristics have already been recognized as risk factors for worse prognosis among patients with COVID-19: older age, higher Sequential Organ Failure Assessment score, and elevated D-dimer[1]; a meta-analysis also established that older than 65 yrs, male sex, and smoking status are associated with an unfavorable course and mortality.[2] Studies in Mexican population have also underscored the importance of obesity, diabetes, pulmonary disease, hypertension, and immunosuppression in the outcome of these patients.[3]

In an already overrun health system, as we have seen during the pandemic, quick assessment and triage of patients are fundamental, the National Institute for Health and Care Excellence guidelines suggest that in patients older than 65 yrs with a Clinical Frailty Scale score of higher than 5, the benefit of intensive care unit (ICU) admission is uncertain and critical care advice is needed; it is also stated that Clinical Frailty Scale may not be useful in younger people with disabilities.[4] Frailty information may not be available in all patients, and it should be pointed out that frailty may frequently coexist with sarcopenia, defined as a skeletal muscle disorder characterized by generalized loss of muscle mass and function.[5] Sarcopenia, although widely recognized among elderly population, can also develop in young patients.[6]

Several noninvasive techniques can estimate muscle quantity; among them, magnetic resonance imaging and computed tomography (CT) are considered to be optimal.[5] The

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measurement of skeletal muscle area (SMA) in a cross-sectional cut strongly correlates to total body skeletal muscle in healthy[7] and oncological populations.[8] Skeletal muscle area may be calculated with different software that multiply the number of pixels within a specified region of interest, with a specific Hounsfield unit threshold according to the tissue under evaluation.[9] Skeletal muscle area assessment with this software has the excellent interrater reliability even among nonexpert observers[10] and does not require patients' active participation.

Low muscle mass assessment in a thoracic CT has been associated with increased length of stay, mortality, and readmission after cardiothoracic surgical procedures[11–13] and worse prognosis in idiopathic pulmonary fibrosis.[14] In addition, low muscle mass has been associated with negative outcomes in critically ill patients, difficulty weaning in a surgical ICU,[15] increased mortality in patients with invasive mechanical ventilation (IMV) with acute and chronic comorbidities,[16–18] and decreased ICU and ventilator-free days in the elderly population.[19]

We hypothesized that a low skeletal muscle mass may have a role in the early identification of patients with COVID-19 with a higher risk for negative outcomes. The aim of this study was to verify whether there was an association between low skeletal muscle index (SMI) and in-hospital mortality, need of IMV, and/or ICU admission.

MATERIALS AND METHODS

Study Population

This was a retrospective cohort study of a tertiary care center in Mexico City that has become a referral center for COVID-19. We included all consecutive patients admitted to the hospital between February 26 and May 15, 2020, with a confirmed diagnosis of COVID-19 that had a thoracic CT scan at admission and that had developed an outcome (i.e., death or hospital discharge) by May 15. We excluded 98 patients without a CT scan. The institutional review board approved and revised this study (Reference No. 333). Written informed consent was waived by the institutional review board because of the observational nature of the study.

Molecular Diagnostic Procedures

SARS-CoV-2 testing was carried out on nasopharyngeal/oropharyngeal swabs (two or more samples per patient, with at least one nasopharyngeal swab) or tracheal aspirate for diagnosis. Upper respiratory samples were transported in a universal transport medium for viruses. Nucleic acid extraction was performed using the NucliSENS EasyMAG system (bioMérieux, Boxtel, the Netherlands). Real-time reverse transcription–polymerase chain reaction was carried out on an Applied Biosystems 7500 thermocycler (Applied Biosystems, Foster City, CA) using primers and conditions described elsewhere.[20] The cycle threshold value for positivity was 38.

Skeletal Muscle Assessment

A transverse CT image at the level of T12 was assessed from each scan. Images were analyzed with the National Institutes of Health ImageJ software, Version 1.48.[21] Briefly, skeletal muscles in the T12 region were manually demarcated and then further identified and quantified by Hounsfield unit thresholds of −29 to +150. Skeletal muscle area (in centimeters) was automatically computed by summing tissue pixels and multiplying by pixel surface area. Skeletal muscle index was computed by normalizing it for stature (in square centimeter per square meter). Low skeletal muscle was defined according to the following cutoffs: SMI of less than 42.6 cm^2/m^2 and less than 30.6 cm^2/m^2 in men and women,[22] respectively. All CT images were analyzed by two trained observers, who were blinded to clinical outcomes and to other imaging studies (PMV and GMZ); intraclass correlation coefficient indicated near complete agreement (intraclass correlation coefficient = 0.92, $P < 0.001$).

Data Collection and Outcomes

Clinical and epidemiological data were extracted at first evaluation using a standardized case report form[23]; the remainder information was obtained from electronic clinical records. Imaging and laboratory studies were performed accordingly to the local protocols. Basal laboratory assessment included complete blood cell count, comprehensive metabolic panel, inflammatory markers, creatine kinase, fibrinogen, D-dimer, and lactate dehydrogenase.[2] The following clinical scores were computed on admission: quick sepsis related organ failure assessment[24] (altered mental status, respiratory rate, and systolic blood pressure), National Early Warning Score[25] (respiratory rate, oxygen saturation, need of supplemental oxygen, temperature, systolic blood pressure, heart rate, and alert, verbally responsive, painfully responsive, unresponsive score), and MuLBSTA[26] (multilobe infiltrate, absolute lymphocyte count, bacterial coinfection, smoking history, hypertension, and age >60 yrs). Quick SOFA, score for sepsis, identifies high-risk patients for in-hospital mortality with suspected infection outside the ICU, and National Early Warning Score determines the degree of illness of a patient and prompts critical care intervention; MuLBSTA score, for viral pneumonia mortality, predicts 90-day mortality in patients with viral pneumonia. A more detailed description about the cohort has been explained before.[27] Patients were followed up until their death or discharge date. The outcomes of interest were death, ICU admission, and need of IMV.

Statistical Analysis

Categorical variables were reported as frequencies and percentages. Continuous variables were described using mean ± standard deviation or median (interquartile range [IQR]), as appropriate. Differences between study groups (low SMI and normal SMI) were assessed using the χ^2 test, the Wilcoxon rank-sum test, and Student's *t* test, as appropriate. We used logistic regression to study the association between muscle mass, as an independent variable, and death, ICU admission, and IMV, as outcome/dependent variables. Covariates were chosen based on clinical plausibility and significance on univariable analysis (i.e., $P < 0.1$). Muscle mass was assessed both quantitatively with the SMI and qualitatively as normal/low SMI. Goodness of fit was assessed with the Hosmer-Lemeshow test. A *P* value of less than 0.05 was considered statistically significant. Statistical analysis was performed using STATA (Stata Statistical Software: Release 14; StataCorp). This study conforms to all Strengthening the Reporting of Observational Studies in Epidemiology guidelines and reports the required information accordingly (see Supplemental Checklist, Supplemental Digital Content 1, http://links.lww.com/PHM/B234).

RESULTS

General Characteristics and Variables Associated With Low SMI

We included 519 patients, the median age was 51 (42–61) yrs, 88 (17%) were older than 65 yrs, and 332 (64%) were male. The most common comorbidities were obesity, arterial hypertension, and diabetes mellitus type 2, with a prevalence of 48% (251), 30% (158), and 26% (137), respectively. Regarding the most common presenting symptoms, cough was present in 477 (92%) patients, fever in 452 (87%), dyspnea in 417 (80%), and headache in 408 (79%). On admission, the quick sepsis related organ failure assessment, National Early Warning Score, and MuLBSTA scores were 1 (1–1), 9 (7–10), and 7 (5–9), respectively.

TABLE 1. Baseline characteristics by muscle mass status

	All (N = 519)	Normal SMI (n = 404)	Low SMI (n = 115)	P
Variable				
Age, yr	51 (42–61)	50 (41–60)	58 (44–65)	<0.001
Male	332 (64)	238 (59)	94 (82)	<0.001
BMI, kg/m^2	29.7 (26.7–33.4)	30.5 (27.9–34.7)	26.3 (23.9–29.2)	<0.001
SMA, mean ± SD, cm^2	122.1 ± 29.1	127.1 ± 28.9	104.5 ± 22.5	<0.001
SMI, cm^2/m^2	44.4 (38.5–51.1)	47.6 (42.5–53.3)	38.1 (33.3–41.3)	<0.001
Comorbidities				
Overweight/obesity	446 (86)	373 (92.3)	73 (63.5)	<0.001
Obesity	251 (48)	230 (57)	21 (18)	<0.001
Diabetes mellitus	137 (26)	98 (24)	39 (34)	0.03
Arterial hypertension	158 (30)	127 (31)	31 (27)	0.3
Coronary artery disease	24 (5)	18 (4.4)	6 (5.2)	0.7
Chronic kidney disease	16 (3)	11 (2.7)	5 (4.3)	0.4
Smoking	91 (18)	68 (17)	23 (20)	0.4
Charlson Index	1 (0–2)	1 (0–2)	2 (0–3)	<0.001
Vital signs				
Temperature, °C	37 (36.5–37.7)	37 (36.5–37.7)	37.1 (36.5–37.7)	0.7
Heart rate, beats/min	102 (90–115)	102 (89–115)	105 (93–115)	0.8
Respiratory rate, breaths/min	27 (22–32)	27 (22–33)	27 (22–32)	0.4
Oxygen saturation on room air, %	85 (75–89)	85 (74–88)	85 (76–90)	0.1
Arterial pressure, mean ± SD, mm Hg	91.1 ± 11.7	91.4 ± 11.8	90.1 ± 11.3	0.1
Prognostic scores				
Quick SOFA	1 (1–1)	1 (1–1)	1 (1–1)	0.7
NEWS score	9 (7–10)	9 (7–10)	9 (7–10)	0.4
MuLBSTA score	7 (5–9)	7 (5–9)	9 (7–10)	0.009
Laboratory results				
Creatinine, mg/dl	0.95 (0.78–1.17)	0.95 (0.78–1.17)	0.96 (0.8–1.16)	0.5
Total bilirubin, mg/dl	0.59 (0.46–0.78)	0.58 (0.44–0.76)	0.62 (0.48–0.80)	0.03
Aspartate amino transferase, U/l	42.6 (30.3–64)	42.1 (30.2–63.5)	44 (30.3–69.6)	0.5
Alanine amino transferase, U/l	37 (24.1–55.1)	37.5 (25–54.4)	36 (22.3–59)	0.7
Alkaline phosphatase, U/l	88 (70–115)	87 (70–114)	95 (70–118)	0.2
Albumin, g/dl	3.7 (3.3–4.0)	3.7 (3.4–4.0)	3.6 (3.3–4.0)	0.3
Leucocytes, mean/µl	7850 (5800–10,700)	7800 (5900–10,700)	7900 (5300–10,700)	0.7
Total lymphocytes, mean/µl	811.9 (585–1074)	841.5 (639–1092)	684.8 (471.2–910)	<0.001
Lactate dehydrogenase, U/l	381.5 (249.5–501)	382 (296–497)	377 (285–521)	0.9
Ferritin, ng/ml	636 (303.6–1029.6)	613.1 (275.8–965.8)	766.4 (339–1250)	0.01
Fibrinogen, mg/dl	688 (501–832)	680 (516–832)	705 (499–860.5)	0.7
D-dimer, ng/ml	680 (436.2–1115)	702 (439–1120)	629 (417–1089)	0.2
US-CRP, mg/dl	14.9 (7.2–23.2)	14.3 (6.7–22.0)	16.2 (10.3–25.2)	0.1
Creatinine phosphokinase, U/l	115 (63–234)	116.5 (64–235)	113 (59–228)	0.4
Hs-TnI, pg/ml	5.4 (3.7–11.5)	5.4 (3.6–11.4)	5.4 (4.2–11.5)	0.4
Pao_2/Fio_2	210 (124.7–265)	209 (119–261.9)	218.5 (148.7–279.7)	0.1
$PaCO_2$, mm Hg	33.7 (28.7–34.4)	32.1 (29.3–34.9)	29.7 (27.6–32.8)	<0.001

Data are presented as median (IQR) or n (%), unless otherwise indicated.

BMI, body mass index; Fio_2, fraction of inspired oxygen; HCO_3^-, bicarbonate; Hs-TnI, high sensitivity troponin I; NEWS, National Early Warning Score; $PaCO_2$, partial pressure of dioxide; Pao_2, partial pressure of oxygen; US-CRP, ultrasensitive C-reactive protein.

TABLE 2. Association between low muscle mass and death

	Univariable			Multivariable								
				Considering SMI			Considering Low SMM			Considering SMA		
	OR	95% CI	*P*	OR	95% CI	*P*	OR	95% CI	*P*	OR	95% CI	*P*
Male	1.71	1.10–2.65	0.02	2.10	1.29–3.41	0.003	2.23	1.38–3.62	0.001	2.98	1.53–5.80	0.001
Age, yr	1.06	1.04–1.07	<0.001	1.07	1.05–1.09	<0.001	1.07	1.05–1.09	<0.001	1.06	1.04–1.09	<0.001
Diabetes mellitus	1.82	1.18–2.80	0.006	1.18	0.73–1.89	0.5	1.16	0.72–1.86	0.5	1.13	0.71–1.82	0.6
Arterial hypertension	1.38	0.90–2.10	0.2	—	—	—	—	—	—	—	—	—
Cardiovascular disease	1.01	0.39–2.59	1.0	—	—	—	—	—	—	—	—	—
BMI, kg/m^2	1.01	0.97–1.04	0.5	1.05	1.00–1.09	0.03	1.06	1.01–1.10	0.009	1.07	1.03–1.12	0.002
SMI, cm^2/m^2	1.01	0.99–1.01	0.2	1.01	1.00–1.02	0.1	—	—	—	—	—	—
Low SMM	1.22	0.76–1.94	0.4	—	—	—	0.95	0.54–1.65	0.8	—	—	—
SMA, cm^2	1.00	0.99–1.01	0.7	—	—	—				0.99	0.98–1.00	0.2

BMI, body mass index; SMM, skeletal muscle mass.

One hundred fifteen patients (22%) had low SMI. Patients with low SMI were older (58 [44–65] yrs vs. 50 [41–60] yrs, $P < 0.001$), had a lower BMI (26.3 [23.9–29.2] kg/m^2 vs. 30.5 [27.9–34.7] kg/m^2, $P < 0.001$), but a higher prevalence of diabetes mellitus type 2 (34% vs. 24%, $P = 0.03$), and lower total lymphocytes (684.8 [471.2–910] mean/µl vs. 841.5 [639–1092] mean/µl, $P < 0.001$). Baseline characteristics of patients can be found in Table 1.

Association Between Muscle Mass and Death

Mortality rate in the whole sample was 25% (129): 24% (97) in patients without and 28% (32) in patients with low SMI ($P = 0.4$). Variables associated with death on univariable analysis were age (odds ratio [OR] = 1.06, 95% confidence interval [CI] = 1.04–1.07, $P < 0.001$), diabetes mellitus type 2 (OR = 1.82, 95% CI = 1.18–2.80, $P = 0.006$), and male sex (OR = 1.71, 95% CI = 1.10–2.65, $P < 0.02$). Low SMI (OR = 1.22, 95% CI = 0.76–1.94, $P = 0.4$) and SMI (OR = 1.01, 95% CI = 0.99–1.01, $P = 0.2$) were not associated with death. On multivariable analysis, male sex, age, and BMI were significantly associated with mortality (Table 2).

Association Between Muscle Mass and ICU Admission and IMV

Overall, 207 patients (40%) required ICU admission: 49 (43%) and 159 (39%) patients with and without low SMI ($P = 0.5$). Variables associated with ICU admission were male sex (OR = 1.74, 95% CI = 1.19–2.54, $P = 0.004$), age (OR = 1.02, 95% CI = 1.01–1.04, $P < 0.001$), diabetes mellitus type 2 (OR = 1.52, 95% CI = 1.02–2.26, $P = 0.03$), BMI (OR = 1.04, 95% CI = 1.01–1.07, $P = 0.02$), and SMI (OR = 1.01, 95% CI = 1.00–1.03, $P = 0.048$). Low SMI was not associated with mortality (OR = 1.15, 95% CI = 0.75–1.75, $P = 0.5$). On multivariable analysis, male sex, age, and BMI, but not SMI, remained associated with ICU admission (Table 3).

A total of 118 patients (23%) required IMV: 28 (24%) and 90 (22%) patients with and without low SMI ($P = 0.6$), respectively. The days of IMV were not different between patients with and without low SMI (12 [6–19] vs. 10 [5–15], $P = 0.5$). On univariable analysis, variables associated with IMV were BMI (OR = 1.05, 95% CI = 1.01–1.08, $P = 0.009$) and SMI (OR = 1.02, 95% CI = 1.00–1.04, $P = 0.03$), but not low SMI (OR = 1.12, 95% CI =

TABLE 3. Association between low muscle mass and ICU admission

	Univariable			Multivariable								
				Considering SMI			Considering Low SMM			Considering SMA		
	OR	95% CI	*P*	OR	95% CI	*P*	OR	95% CI	*P*	OR	95% CI	*P*
Male	1.74	1.19–2.54	0.004	1.96	1.30–2.98	0.002	2.02	1.34–3.03	0.001	2.08	1.19–3.62	0.01
Age, yr	1.02	1.01–1.04	<0.001	1.04	1.02–1.05	<0.001	1.04	1.02–1.05	<0.001	1.04	1.02–1.05	<0.001
Diabetes mellitus	1.52	1.02–2.26	0.03	1.21	0.78–1.84	0.4	1.17	0.77–1.80	0.5	1.19	0.78–1.82	0.4
Arterial hypertension	1.16	0.79–1.70	0.4	—	—	—	—	—	—	—	—	—
Cardiovascular disease	0.90	0.39–2.10	0.8	—	—	—	—	—	—	—	—	—
BMI, kg/m^2	1.04	1.01–1.07	0.02	1.06	1.02–1.09	0.004	1.07	1.03–1.11	<0.001	1.06	1.02–1.10	0.001
SMI, cm^2/m^2	1.01	1.00–1.03	0.048	1.01	0.99–1.02	0.3	—	—	—	—	—	—
Low SMM	1.15	0.75–1.75	0.5	—	—	—	1.20	0.74–1.95	0.5	—	—	—
SMA, cm^2	1.00	1.00–1.01	0.06	—	—	—	—	—	—	1.00	0.99–1.00	0.9

BMI, body mass index; SMM, skeletal muscle mass.

TABLE 4. Association between low muscle mass and mechanical ventilation

	Univariable			Multivariable								
				Considering SMI			Considering Low SMM			Considering SMA		
	OR	95% CI	*P*	OR	95% CI	*P*	OR	95% CI	*P*	OR	95% CI	*P*
Male	1.37	0.88–2.13	0.1	1.36	0.85–2.22	0.2	1.38	0.87–2.19	0.2	1.45	0.76–2.76	0.2
Age, yr	0.99	0.97–1.00	0.3	1.00	0.98–1.01	0.7	0.99	0.98–1.01	0.5	0.99	0.97–1.01	0.6
Diabetes mellitus	1.10	0.70–1.75	0.6	1.20	0.74–1.96	0.4	1.15	0.71–1.88	0.6	1.18	0.72–1.92	0.5
Arterial hypertension	0.72	0.45–1.15	0.2	—	—	—	—	—	—	—	—	—
Cardiovascular disease	1.14	0.44–2.94	0.8	—	—	—	—	—	—	—	—	—
BMI, kg/m^2	1.05	1.01–1.08	0.009	1.04	1.00–1.08	0.06	1.06	1.02–1.10	0.004	1.05	1.01–1.09	0.02
SMI, cm^2/m^2	1.02	1.00–1.04	0.03	1.01	0.99–1.02	0.3	—	—	—	—	—	—
Low SMM	1.12	0.69–1.85	0.6	—	—	—	1.52	0.87–2.63	0.1	—	—	—
SMA, cm^2	1.01	1.00–1.01	0.046	—	—	—	—	—	—	1.00	0.98–1.01	1.0

BMI, body mass index; SMM, skeletal muscle mass.

0.69–1.85, $P = 0.6$). On multivariable analysis, BMI, but not SMI, remained independently associated with IMV (Table 4).

Role of Skeletal Muscle in Elderly Patients

We assessed the role of SMI in the 88 patients (17%) 65 yrs or older, and results did not change in comparison with the whole population: SMI and low SMI were not associated with mortality, ICU admission, or IMV.

Role of Skeletal Muscle by Sex

We conducted separate analysis for men and women, overall results did not change, and muscle mass was not associated with any of the outcomes of interest (Table 5).

DISCUSSION

The aim of this study was to verify whether SMI assessed by cross-sectional imaging could be used as a prognostic factor for clinically relevant outcomes, such as mortality, ICU admission, and IMV need in hospitalized patients with COVID-19. However, we did not find an association between SMA, SMI, or low SMI and these outcomes.

Although other studies have found adverse outcomes in patients with low muscle mass in the context of chronic diseases like pulmonary fibrosis or cancer[13,14] and in diverse critically ill patients (i.e., surgical, oncologic, nononcologic, elderly population),[15–18] in hospitalized patients with COVID-19, SMI does not seem to have a role in predicting adverse outcomes. We think that this may be explained by the acute and aggressive course of COVID-19, which may lead patients to multisystem inflammation, multiple organ failure, and death, rather than to prolonged mechanical ventilation.

These findings suggest that previous muscle mass in patients with COVID-19 may not be a crucial determinant of the disease course and should not be considered when deciding ICU admission, not even among elderly patients. On the other hand, these results do not mean that sarcopenia or frailty, being more comprehensive conditions, has no prognostic role, and more research would be needed to fully understand them.[28] Hewitt et al.[29] recently showed that frailty plays an important role in the survival of patients with COVID-19, supporting the National Institute for Health and Care Excellence guidance on admission to critical care. Allocation of resources during this pandemic has been an area of great controversy, but it is evident that more than chronological age, it is the number of comorbidities and the level of fitness, not just muscle mass, that matters.[3,25] Along these lines, we could corroborate previous findings in the literature[1–3]: male sex and age were associated

TABLE 5. Association between muscle mass and outcomes by sex[a]

	Death			ICU Admission			Invasive Mechanical Ventilation		
	OR	95% CI	*P*	OR	95% CI	*P*	OR	95% CI	*P*
Female									
SMI, cm^2/m^2	1.01	0.99–1.03	0.1	1.01	0.99–1.02	0.4	1.01	0.99–1.02	0.4
Low SMM	2.03	0.60–6.87	0.2	2.29	0.83–6.34	0.1	2.81	0.89–8.82	0.08
SMA, cm^2	0.99	0.97–1.01	0.7	1.00	0.99–1.02	0.6	1.00	0.98–1.02	0.8
Male									
SMI, cm^2/m^2	0.99	0.95–1.03	0.7	1.01	0.96–1.04	0.7	1.01	0.97–1.05	0.6
Low SMM	0.77	0.40–1.49	0.4	1.04	0.58–1.85	0.9	1.35	0.70–2.58	0.4
SMA, cm^2	0.99	0.97–1.00	0.1	0.99	0.98–1.01	0.5	1.00	0.98–1.01	0.7

[a]Adjusted by age, diabetes mellitus status, arterial hypertension status, cardiovascular disease status, and body mass index.
SMM, skeletal muscle mass.

with mortality, and in addition to these three variables, ICU admission was also associated with BMI. Invasive mechanical ventilation need was also associated with BMI.

The study has some limitations. Firstly, SMI at T12 seems to have a lower correlation with total body muscle mass when compared with SMI at the level of L3[30] and is probably a poor surrogate of age-associated sarcopenia.[31] However, thoracic CT is widely available in patients with severe COVID-19 pneumonia, and these findings could be easily reproduced in other cohorts. Because of its availability, SMI at T12 has been shown to be a robust predictor of negative outcomes in different lung pathologies.[11–19] Secondly, as SMI was the only sarcopenia criteria evaluated, the role of skeletal muscle function in the outcomes of these patients is still unknown, and these results should not be confused with the role that sarcopenia or frailty may have.

CONCLUSIONS

Low SMI determined by CT at the level of T12 was not associated with mortality, ICU admission, or IMV need in hospitalized patients with COVID-19. Further research is needed to determine the impact of young and old patient's previous muscle function, not only mass, in the impact of COVID-19.

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