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The Impact of Sarcopenia on the Clinical Profile of Hospitalized Pulmonary Embolism Patients: A Longitudinal Cohort Study

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Abstract

Pulmonary embolism (PE) is a potentially life-threatening cardiopulmonary condition that frequently requires hospitalization and is often accompanied by reduced mobility, systemic inflammation, and nutritional impairment. These factors may contribute to the development or worsening of sarcopenia, a condition associated with adverse outcomes in hospitalized patients. However, its clinical relevance in patients with PE has not been sufficiently explored. This longitudinal observational cohort study evaluated the association between sarcopenia and clinical outcomes in patients hospitalized with confirmed PE. Participants were classified according to the presence of sarcopenia based on muscle mass and muscle strength criteria. Symptom severity, functional status, and health-related quality of life were assessed at hospital admission, at discharge, and three months after discharge. A total of 162 patients were included. Patients with sarcopenia exhibited a greater symptom burden, poorer functional status, and worse self-perceived health compared with non-sarcopenic patients. At discharge, sarcopenic patients reported higher levels of dyspnea and fatigue, poorer health-related quality of life, and experienced longer hospital stays. At the three-month follow-up, these patients continued to show significantly worse symptoms, reduced functionality, and lower quality of life. Sarcopenia was therefore associated with a persistently worse clinical and functional profile in patients hospitalized for PE. Early identification of sarcopenia may help identify patients at higher risk of poor recovery and support the implementation of targeted interventions aimed at improving functional outcomes and quality of life.

Keywords: pulmonary embolism; sarcopenia; hospitalization; quality of life; symptoms severity; recovery; mobility

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1. Introduction

Acute pulmonary embolism (PE) is a serious and potentially life-threatening condition caused by the sudden obstruction of the pulmonary arteries, most commonly due to thrombi originating in the deep veins of the lower extremities that migrate to the lungs [1]. PE represents the third most frequent acute cardiovascular syndrome worldwide, after myocardial infarction and stroke [2]. Although its true incidence is difficult to determine, epidemiological estimates suggest that PE affects approximately 60–120 individuals per 100,000 inhabitants each year [3].

Several well-established risk factors contribute to the development of PE, including advanced age, previous venous thromboembolism, active cancer, cardiac or respiratory failure, congenital or acquired coagulation disorders, and hormonal therapies [4]. Clinically, PE presents with a broad spectrum of manifestations, ranging from mild dyspnea and fatigue to syncope and hemodynamic instability, reflecting varying degrees of respiratory and circulatory compromise [5]. Due to this heterogeneity and the potential for rapid clinical deterioration, more than 80% of patients diagnosed with PE require hospital admission for monitoring and treatment [6].

Hospitalization for acute PE represents a critical period of vulnerability. During admission, patients are frequently exposed to reduced mobility, bed rest, acute illness-related stress, and nutritional impairment, all of which can lead to rapid physical deconditioning and loss of muscle mass and strength [7,8]. Malnutrition, which is highly prevalent among hospitalized and older adults, is often accompanied by a chronic low-grade inflammatory state that promotes muscle protein breakdown and accelerates muscle catabolism [9].

In parallel, inflammation plays a central role in the pathophysiology of pulmonary embolism through its close interaction with the coagulation system, a process increasingly described as immunothrombosis [10,11]. This inflammatory–thrombotic milieu contributes not only to clot formation and propagation but also to systemic effects that may impair recovery. The coexistence of immobilization, inflammation, and nutritional deficits may therefore amplify muscle loss in patients hospitalized for PE, reinforcing the multifactorial nature of sarcopenia in this population and increasing the risk of adverse clinical and functional outcomes [6,12].

Sarcopenia is defined as a generalized and progressive loss of skeletal muscle mass and function and is now widely recognized as a marker of reduced physiological reserve and increased vulnerability [13]. Its prevalence varies widely, ranging from 5% to 40% depending on the population and diagnostic criteria used [14,15]. In hospitalized patients, sarcopenia has consistently been associated with worse clinical course, prolonged length of hospital stay, impaired functional recovery, and poorer prognosis [16,17]. The impact of sarcopenia has been extensively studied in chronic respiratory diseases such as chronic obstructive pulmonary disease (COPD), where it is linked to greater symptom burden, delayed recovery, reduced quality of life, and increased healthcare utilization [18,19]. Pulmonary embolism shares several pathophysiological features with chronic respiratory conditions, including systemic inflammation, hypoxemia, reduced physical activity, and periods of enforced immobility during hospitalization. These similarities suggest that sarcopenia may play a comparable detrimental role in patients with PE, potentially influencing symptom severity, functional status, and recovery trajectories [20].

However, despite growing interest in muscle health as a prognostic factor in acute and chronic diseases, evidence regarding the prevalence and clinical relevance of sarcopenia in patients hospitalized for PE remains limited.

To date, few studies have specifically examined the influence of sarcopenia on the clinical course of PE, and longitudinal data assessing its impact on symptoms, functionality, and health-related quality of life during hospitalization and after discharge are scarce. Addressing this gap could provide valuable insights for identifying high-risk patients and for guiding the development of targeted rehabilitation and nutritional strategies aimed at optimizing recovery and long-term outcomes.

2. Materials and Methods

2.1. Study Design and Participants

A longitudinal observational cohort study was conducted. The study adhered to the recommended guidelines for the design and reporting of observational studies and followed the criteria and checklist of the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement [21]. The study was conducted in accordance with the Declaration of Helsinki (1975), as revised in 2013 ("World Medical Association Declaration of Helsinki," 2013). The study protocol was reviewed and approved by the Biomedical Research Ethics Committee of Granada (Granada, Spain) (approval ID: 1770-N-23).

Patients diagnosed with pulmonary embolism who were aged 18 years or older were recruited from the Pulmonology Service of Hospital Universitario San Cecilio (Granada, Spain) between September 2022 and June 2024. All participants provided written informed consent prior to inclusion in the study. Exclusion criteria included cognitive impairment, physical conditions that prevented the performance of the assessments, neurological disorders affecting voluntary mobility, or inability to participate in the follow-up evaluations.

2.2. Group Assignment

Patients were classified into two groups according to the presence of sarcopenia, defined by the coexistence of low muscle mass and reduced muscle strength. Muscle mass was assessed using calf circumference (CC) as a surrogate marker, applying the consensus-based cut-off value of <31 cm to indicate reduced muscle mass, as recommended by the European Working Group on Sarcopenia in Older People (EWGSOP) [22]. This cut-off value is considered an indicator of sarcopenia and has been associated with disability and decreased self-reported physical function [23]. Measurements were obtained using a standard anthropometric tape while the patient was standing upright. The tape was placed around the widest part of the non-dominant calf, ensuring that it did not compress the subcutaneous tissue.

Muscle strength was evaluated using handgrip strength, measured with a Jamar Hand Dynamometer (Sammons Preston Rolyan, Chicago, IL, USA) in accordance with the American Society of Hand Therapists' recommendations. Participants were seated during the test and were instructed to squeeze the dynamometer with maximal effort. The highest value from three attempts per hand, with a one-minute rest interval between attempts, was recorded. Test administrators ensured that maximal effort was exerted before accepting the result. Low muscle strength was defined as <30 kg for men and <20 kg for women [22,23].

2.3. Data Collection

Data collection was conducted at three time points: at hospital admission, at discharge, and three months after discharge. At baseline, patients underwent an initial assessment that included anthropometric and sociodemographic data, including age, sex, and body mass index.

Medical history data included comorbidities, which were assessed using the Charlson Comorbidity Index, a widely recognized and validated scoring system across multiple diseases [24]. Disease severity and risk stratification in patients with pulmonary embolism were evaluated using the Pulmonary Embolism Severity Index (PESI) [25].

2.4. Outcome Measures

The outcomes assessed included symptoms (dyspnea and fatigue), health status, and functionality.

The primary outcome of the study was functionality, assessed using the World Health Organization Disability Assessment Schedule 2.0 (WHODAS 2.0; World Health Organization, Geneva, Switzerland) [26]. The WHODAS 2.0 evaluates disability and functioning across six domains: cognition, mobility, self-care, interpersonal relationships, life activities, and participation in society, providing both domain-specific scores and a total disability score.

Secondary outcomes included symptom burden and health status. Symptom burden was evaluated through the assessment of dyspnea and fatigue. Dyspnea was measured using the modified Borg Dyspnea Scale, which ranges from 0 (no respiratory distress) to 10 (maximum imaginable respiratory distress). Fatigue was assessed using a visual analog scale (VAS), ranging from 0 (no fatigue) to 10 (extreme fatigue).

Health status was evaluated using the EQ-5D questionnaire (EuroQol Research Foundation, Rotterdam, The Netherlands) [27], a standardized instrument for measuring self-perceived health. The EQ-5D assesses five dimensions—mobility, self-care, usual activities, pain/discomfort, and anxiety/depression—each rated on a five-level scale ranging from no problems to extreme problems. In addition, participants rated their overall health using the EQ-5D visual analog scale (VAS), which ranges from 0 (worst imaginable health) to 100 (best imaginable health).

2.5. Statistical Analysis

Statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS), version 28.0.1 (IBM Corp., Armonk, NY, USA). Descriptive statistics were used to summarize baseline characteristics of the sample and are presented as mean ± standard deviation for continuous variables or as frequencies and percentages for categorical variables. The normality of continuous variables was assessed using the Kolmogorov–Smirnov test.

Continuous variables with a normal distribution were compared using the independent samples Student's *t*-test, whereas non-normally distributed variables were analyzed using the Mann–Whitney U test. Between-group comparisons were conducted after stratifying participants according to the presence of sarcopenia [23]. A 95% confidence interval was applied, and statistical significance was set at a p-value < 0.05.

3. Results

A total of 182 patients hospitalized with pulmonary embolism were included in the study and classified into two groups according to the presence of sarcopenia. The flow of patient inclusion and grouping is shown in Figure 1.

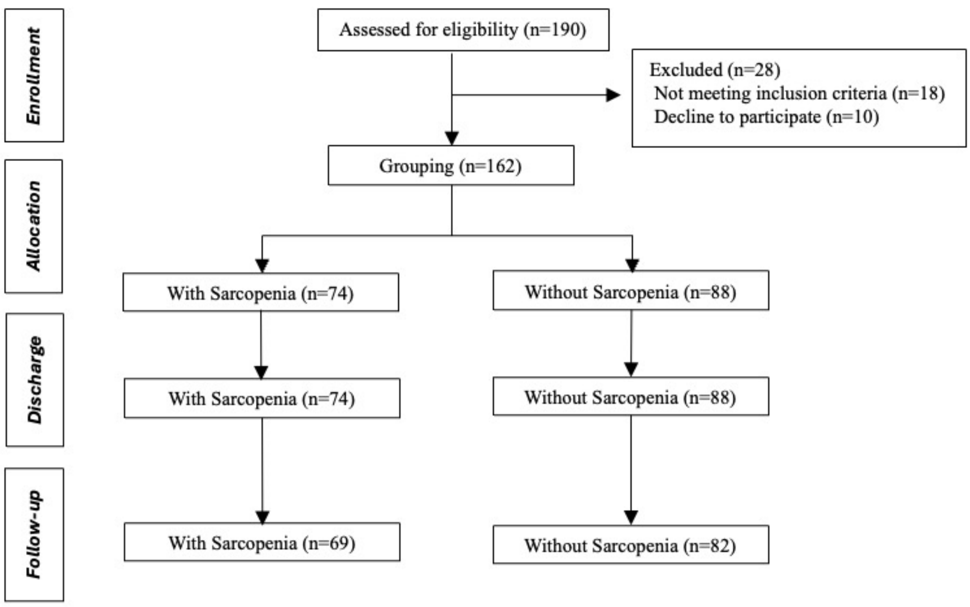

Figure 1. Flow diagram of the included participants.

Table 1 presents the baseline characteristics, symptom severity, health status, and functional outcomes of both groups at hospital admission.

Table 1. Baseline characteristics of pulmonary embolism patients at hospital admission.

	PE Patients Without Sarcopenia (n = 88)	PE Patients with Sarcopenia (n = 74)	CI (95%)	*p*-Value
Sex n (% of men)	49.24	52.61		0.631
Age (years)	55.43 ± 15.71	66.62 ± 16.71		<0.001 **
BMI (kg/m^2)	30.26 ± 4.66	28.33 ± 4.65		0.008 *
Charlson Comorbidity Index	2.81 ± 2.5	4.39 ± 2.76		0.001 *
Pulmonary Embolism Severity Index	80.14 ± 21.66	87.36 ± 23.95		0.08
Symptomatic outcomes				
Dyspnea	1.35 ± 2.02	2.44 ± 2.87	−1.08 [−1.89, −0.28]	0.009 *
Fatigue	2.71 ± 2.67	5.16 ± 3.28	−2.44 [−3.38, −1.51]	<0.001 **
Functionality				
Cognition	8.32 ± 5.18	8.76 ± 4.26	−0.43 [−1.93, 1.05]	0.562
Mobility	8.68 ± 5.57	12.59 ± 6.91	−3.91 [−5.84, −1.97]	<0.001 **
Self-care	5.23 ± 3.58	7.41 ± 4.40	−2.17 [−3.41, −0.93]	0.001 *
Activity daily	6.55 ± 5.11	10.08 ± 6.41	−3.53 [−5.32, −1.74]	<0.001 **
Getting along with people	6.09 ± 3.47	7.46 ± 3.18	−1.36 [−2.41, −0.32]	0.010 *
Participation	12.50 ± 7.18	16.44 ± 7.85	−3.94 [−6.29, −1.59]	0.001 *
Total	55.23 ± 32.75	67.92 ± 27.68	−12.69 [−22.2, −3.17]	0.009 *
Health status				
Mobility	2.41 ± 1.37	2.43 ± 1.13	−0.02 [−0.42, 0.37]	0.908
Self-care	2.14 ± 1.33	2.05 ± 1.14	0.08 [−0.31, 0.47]	0.677
Daily activities	2.45 ± 1.20	2.32 ± 1.21	0.13 [−0.24, 0.51]	0.496
Pain/Discomfort	1.82 ± 0.78	1.84 ± 1.01	−0.02 [−0.29, 0.25]	0.889
Anxiety/Depression	1.68 ± 0.97	1.65 ± 0.78	0.03 [−0.24, 0.31]	0.814
Total	57.14 ± 22.11	50.71 ± 25.89	6.43 [−1.17, 14.03]	0.097

BMI: Body Mass Index, CI: Confidence Interval, EQ-5D: European Quality of Life-5 Dimensions, PE: Pulmonary Embolism, WHODAS: World Health Organization Disability Assessment Schedule. Data expressed as Mean ± Standard deviation or percentage (%); * $p < 0.05$; ** $p < 0.001$.

Patients without sarcopenia were younger and had a higher body mass index compared with patients with sarcopenia. The Charlson Comorbidity Index was significantly higher in the sarcopenia group ($p = 0.001$); however, no significant differences were observed between groups in pulmonary embolism severity as assessed by the Pulmonary Embolism Severity Index.

Significant between-group differences were observed in symptom-related outcomes. Patients with sarcopenia reported higher levels of dyspnea and fatigue ($p = 0.009$ and $p < 0.001$, respectively). Functional assessment revealed significantly greater overall disability among sarcopenic patients, particularly in domains related to mobility and daily activities. In addition, patients with sarcopenia demonstrated poorer outcomes in the mobility and pain/discomfort dimensions of the EQ-5D questionnaire.

Table 2 presents the symptomatic and health status differences between groups at discharge. The sarcopenia group had a longer length of hospital stay (7.48 vs. 6.41 days). At discharge, dyspnea and fatigue improved in both groups but remained significantly higher in sarcopenic patients, who also reported a significantly worse health-related quality of life.

Table 3 presents the symptom burden, functional outcomes, and health status of patients three months after hospital discharge. At the three-month follow-up, patients with sarcopenia continued to report a significantly higher symptom burden and poorer functional outcomes compared with non-sarcopenic patients. The WHODAS 2.0 domains showing significant between-group differences were self-care, getting along with people, and participation in society.

Table 2. Symptomatic outcomes and health status changes between groups at hospital discharge.

	PE Patients Without Sarcopenia (n = 88)	PE Patients with Sarcopenia (n = 74)	CI (95%)	*p*-Value
Length of hospital stay (days)	6.41 ± 6.57	7.38 ± 5.45		0.314
Symptomatic outcomes				
Dyspnea	0 ± 0	1.07 ± 2.21	−1.07 [−1.91, −0.23]	0.013 *
Fatigue	0.57 ± 1.06	2.36 ± 3.32	−1.79 [−3.10, −0.49]	0.008 *
Health status				
Mobility	1.42 ± 0.74	2.05 ± 1.29	−0.62 [−1.16, −0.07]	0.025 *
Self-care	1.14 ± 0.35	1.89 ± 1.39	−0.75 [−1.29, −0.21]	0.007 *
Daily activities	1.71 ± 0.89	2.21 ± 1.45	−0.49 [−1.11, 0.12]	0.116
Pain/Discomfort	1.57 ± 0.74	1.31 ± 0.66	0.25 [−0.09, 0.6]	0.146
Anxiety/Depression	1.28 ± 0.46	1.31 ± 0.57	−0.03 [−0.29, 0.23]	0.820
Total	81.42 ± 12.38	68.36 ± 17.67	13.06 [5.26, 20.85]	0.001 *

CI: Confidence Interval, EQ-5D: European Quality of Life-5 Dimensions, PE: Pulmonary Embolism. Data expressed as Mean ± Standard deviation. * $p < 0.05$.

Table 3. Symptoms, functionality and health status of patients at 3 months follow-up.

	PE Patients Without Sarcopenia (n = 88)	PE Patients with Sarcopenia (n = 74)	CI (95%)	*p*-Value
Symptomatic outcomes				
Dyspnea	0 ± 0	2.25 ± 2.43	−2.25 [−3.33, −1.16]	<0.001 **
Fatigue	0.20 ± 0.41	6.00 ± 1.30	−5.80 [−6.45, −5.14]	<0.001 **
Functionality				
Cognition	7.40 ± 2.39	6.75 ± 1.38	0.65 [−1.21, 2.5]	0.480
Mobility	6.40 ± 1.78	9.00 ± 5.07	−2.60 [−5.21, 0.01]	0.051
Self-care	4.00 ± 0	8.75 ± 7.06	−4.75 [−7.90, −1.59]	0.005 *
Activity daily	7.40 ± 6.47	8.75 ± 7.06	−1.35 [−7.05, 4.35]	0.631
Getting along with people	5.80 ± 1.64	8.20 ± 2.05	−2.45 [−3.96, −0.93]	0.003 *
Participation	10.20 ± 2.09	17.50 ± 14.13	−7.30 [−13.79, −0.80]	0.029 *
Total	42.40 ± 13.21	59.00 ± 33.93	−16.60 [−34.58, 1.38]	0.069
Health status				
Mobility	1.20 ± 0.41	2.50 ± 1.19	−1.3 [−1.91, −0.68]	<0.001 **
Self-care	1.00 ± 0	2.00 ± 1.31	−1 [−1.58, −0.41]	0.002 *
Daily activities	1.00 ± 0	2.25 ± 1.75	−1.25 [−2.03, −0.46]	0.003 *
Pain/Discomfort	1.60 ± 0.82	2.25 ± 1.16	−0.65 [−1.44, 0.14]	0.105
Anxiety/Depression	1.60 ± 0.50	1.75 ± 0.88	−0.15 [−0.69, 0.39]	0.574
Total	74.00 ± 13.91	62.50 ± 19.08	11.5 [−1.81, 24.81]	0.087

CI: Confidence Interval, EQ-5D: European Quality of Life-5 Dimensions, PE: Pulmonary Embolism, WHODAS: World Health Organization Disability Assessment Schedule. Data expressed as Mean ± Standard deviation; * $p < 0.05$; ** $p < 0.001$.

4. Discussion

This study aimed to assess the presence of sarcopenia in patients with pulmonary embolism (PE) and to analyze its influence on symptoms, functionality, health status, and recovery during hospitalization and after discharge.

Our findings shows that sarcopenia significantly influences the clinical course of PE, being associated with longer hospital stays, a higher symptom burden, worse functional status, and lower quality of life at admission, as well as poorer recovery over time. Sarcopenia is a well-established prognostic factor in several respiratory diseases [28–30]; therefore, improving our understanding of its role in PE is essential for the development of interventions focused on physical activity, structured exercise training, and nutritional support in these patients.

From a pathophysiological perspective, these findings may reflect shared inflammatory mechanisms between sarcopenia and pulmonary embolism. Sarcopenia is frequently associated with a chronic low-grade inflammatory state, often linked to aging and malnutrition, which contributes to reduced physiological reserve and impaired recovery [10]. At the same time, inflammation plays a central role in the pathophysiology of PE through its close interaction with the coagulation system [12]. The inflammation-thrombosis interplay has recently been highlighted as a relevant determinant of PE severity and prognosis, particularly in older patients, and may partially explain the worse clinical profile observed in sarcopenic individuals [11].

The study sample appears representative of the general population of patients with PE, as the sociodemographic characteristics are consistent with those reported in previous studies [31]. Patients in the sarcopenia group were older, which is consistent with the well-documented increase in sarcopenia prevalence with advancing age [14]. Body mass index was lower in this group, likely reflecting the presence of muscle loss. Additionally, the length of hospital stay was significantly longer in sarcopenic patients, in line with the findings reported by Keller et al. (2024) [14] in patients with PE. More broadly, sarcopenia has been shown to be independently associated with prolonged hospitalization across multiple clinical populations [32].

Regarding symptom burden, significant differences between groups were observed at hospital admission, at discharge, and at the three-month follow-up, with sarcopenic patients reporting persistently worse symptoms over time. These findings are consistent with those reported by De Lorenzo et al. (2022) [33], suggesting that poor muscle quantity and quality are associated with prolonged respiratory symptoms during recovery from respiratory disease.

Functional outcomes were also significantly poorer among patients with sarcopenia. Hospital-related inactivity and bed rest are known to pose substantial risks to muscle tissue, leading to rapid declines in muscle mass and functional capacity [34,35]. Previous research in patients with COPD has shown that sarcopenia is associated with worse functional status at discharge [36]. Similarly, Altuna-Venegas et al. (2019) [37] reported poorer functional outcomes and a higher risk of disability in patients hospitalized for pneumonia, further supporting the detrimental impact of sarcopenia on functional recovery following acute illness.

Sarcopenia also has a profound impact on health status and perceived quality of life. In the present study, self-reported quality of life was significantly lower in sarcopenic patients at discharge and during follow-up, particularly in the mobility dimension. These findings are consistent with previous studies in COPD patients [38]. In other clinical conditions, such as cardiovascular disease, where sarcopenia often coexists with inflammation and functional impairment, it has similarly been associated with poorer quality of life [39]. A recent systematic review confirmed a significant reduction in quality of life among sarcopenic individuals compared with non-sarcopenic counterparts [40], likely reflecting the broad range of adverse outcomes linked to sarcopenia, including impaired mobility, disability, falls, fractures, and increased mortality [41,42].

Future studies are needed to evaluate the effectiveness of targeted interventions in patients with pulmonary embolism and sarcopenia. Exercise-based interventions, nutritional supplementation, and pharmacological approaches have demonstrated benefits in the management of sarcopenia in other populations [43,44] and may hold promise for improving recovery in this clinical context.

Despite the consistent association between sarcopenia and worse clinical, functional, and quality-of-life outcomes observed in this study, the results should be interpreted with caution. Much of the existing evidence derives from observational cohort studies and meta-analyses that demonstrate associations between sarcopenia and adverse outcomes, including mortality, prolonged hospitalization, and readmissions, across diverse populations such as critically ill patients, hospitalized adults, and older individuals, without establishing causality [45,46]. Umbrella reviews of observational studies have linked sarcopenia to a wide range of poor health outcomes; however, the quality of evidence is often rated as low or very low, and residual confounding remains a concern [47]. Thus, sarcopenia likely reflects reduced physiological reserve and global vulnerability rather than acting as a sole causal determinant of poor recovery, while still serving as a clinically meaningful prognostic marker.

In this context, blood cell–derived inflammatory indices have been proposed as useful tools for short-term risk stratification in pulmonary embolism. These markers may help capture the inflammatory-thrombotic milieu underlying both PE and sarcopenia and could refine the prognostic interpretation of sarcopenia in future studies [48].

This study has several limitations. First, the SARC-F questionnaire [49], recommended by the EWGSOP2 guidelines as an initial screening tool for sarcopenia [42], was not used. However, given the limited evidence on sarcopenia in patients hospitalized for PE, all participants were systematically assessed to better understand the impact of sarcopenia on in-hospital and post-discharge recovery. Second, muscle mass was assessed using calf circumference and muscle strength measures. Although these methods are widely used and validated, calf circumference may be influenced by factors such as peripheral edema, fluid retention, obesity, or fat infiltration and does not provide information on muscle quality, making it less precise than imaging-based techniques [50].

Additionally, the absence of nutritional risk screening limits the ability to disentangle the contribution of malnutrition from sarcopenia-related outcomes. Significant baseline differences were also observed between sarcopenic and non-sarcopenic patients. Due to the exploratory observational design, multivariate regression analyses adjusting for potential confounders were not performed. Therefore, the observed differences in clinical, functional, and health-related outcomes cannot be attributed exclusively to sarcopenia. Future studies with larger sample sizes and appropriate multivariate analytical approaches are needed to clarify the independent role of sarcopenia in the prognosis and recovery of patients with pulmonary embolism.

5. Conclusions

Sarcopenia is associated with a significantly worse clinical profile in patients hospitalized for pulmonary embolism. Patients with sarcopenia exhibited poorer functional status, greater symptom burden, and worse self-perceived health at admission, discharge, and three months after hospitalization compared with non-sarcopenic patients.

Functional impairment was more pronounced and persistent in sarcopenic patients, supporting the prognostic relevance of muscle loss in limiting recovery and autonomy following pulmonary embolism. These findings highlight the importance of early identification of sarcopenia in hospitalized PE patients as part of a comprehensive clinical assessment.

Targeted interventions aimed at preserving or improving muscle mass and function, including exercise-based rehabilitation and nutritional strategies, may contribute to better functional recovery, reduced symptom persistence, and improved quality of life in this population and warrant further investigation in future interventional studies.

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data presented in this study are available on request from the corresponding author. The data are not publicly available due to privacy.

Conflicts of Interest: The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

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