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Systematic Review Article

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Psoas and Masseter Sarcopenia as Predictors of Outcome in Neurocritical Patients: A Systematic Review

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Abstract

Objective: To systematically review literature on the predictive value of masseter and psoas muscle sarcopenia in neurocritical patients. ***Design:*** Systematic Review. ***Subjects/Patients:*** Adults (≥ 18 years) with traumatic brain injury and ischemic and/or hemorrhagic stroke. ***Methods:*** PRISMA-guided search of PubMed, Embase and Scopus; screening via Rayyan.ai; methodological assessment by ROBINS-I and AMSTAR2. Data included demographics, muscle areas, mortality, functional outcomes, and intensive care unit/hospital length of stay. ***Results:*** From 465 records, 6 studies (n = 962) met inclusion. Sarcopenic patients exhibited lower masseter and psoas muscle areas, correlating with higher mortality, poorer functional outcomes (Modified Rankin Scale, Glasgow Outcome Scale), and increased discharge to long-term care. Although direct length of stay data was limited, indirect measures (ventilator-free days and pneumonia rates) suggest reduced muscle mass is associated with prolonged stay. ***Conclusion:*** Masseter and psoas sarcopenia are potential predictors of adverse outcomes in neurocritical subjects. Further research is warranted to standardize sarcopenia assessment and integrate these markers into clinical risk stratification.

Keywords: ***Hemorrhagic Stroke; Ischemic Stroke; Masseter Muscle; Psoas Muscle; Sarcopenia; Traumatic Brain Injury***

Introduction

Sarcopenia is defined as a progressive and generalized skeletal muscle disorder, with loss of strength and neuromuscular function, in addition to significantly higher levels of inflammatory biomarkers in lung cancer and colorectal cancer [1-4].

Similarly, in neurocritical patients, there are significant implications, such as in cases of neuroendocrine neoplasms (NENs) [5]. Furthermore, a strong overlap has been identified between sarcopenia and neurodegenerative disorders like Alzheimer's and Parkinson's diseases, and the correlation of this muscle disorder with low survival rates in patients with metastatic gastroenteropancreatic neuroendocrine tumors has also been studied [6].

In parallel, sarcopenia has been identified as a predictor of unfavorable outcomes in various neurological conditions due to trauma, including severe traumatic brain injury (TBI), with mortality rates higher than those in patients without detected sarcopenia [7]. In this context, measuring muscle mass through the evaluation of the psoas major and masseter muscles via abdominal and cranial CT scans for the identification of sarcopenia has proven to be effective, with better prognosis demonstrated in patients with a higher percentage of muscle mass [8-10].

However, there is a lack of standardization in the definition of sarcopenia based on the analysis of the masseter and psoas muscles, which hinders the comparison of studies addressing this analysis and consequently increases the obstacles to validating findings in different populations of neurocritical patients [10]. In this context, this study aims to systematically review and analyze the current evidence on the association between masseter and psoas muscle sarcopenia and poor outcomes in neurocritical care patients.

Methods

Search Strategy

This systematic review was conducted according to the preferred reporting items for systematic reviews and meta-analysis (PRISMA) guidelines [11]. The search strategy was conducted using Medical Subject Headings (MeSH) across Medline, Embase and Scopus. MeSH terms were carefully aligned to find an intersection of the use of psoas and masseter muscle on predicting bad outcomes. More details can be found in Figure 1. Furthermore, this review was registered on the international prospective register of systematic reviews (PROSPERO, reference number: CRD420251003452).

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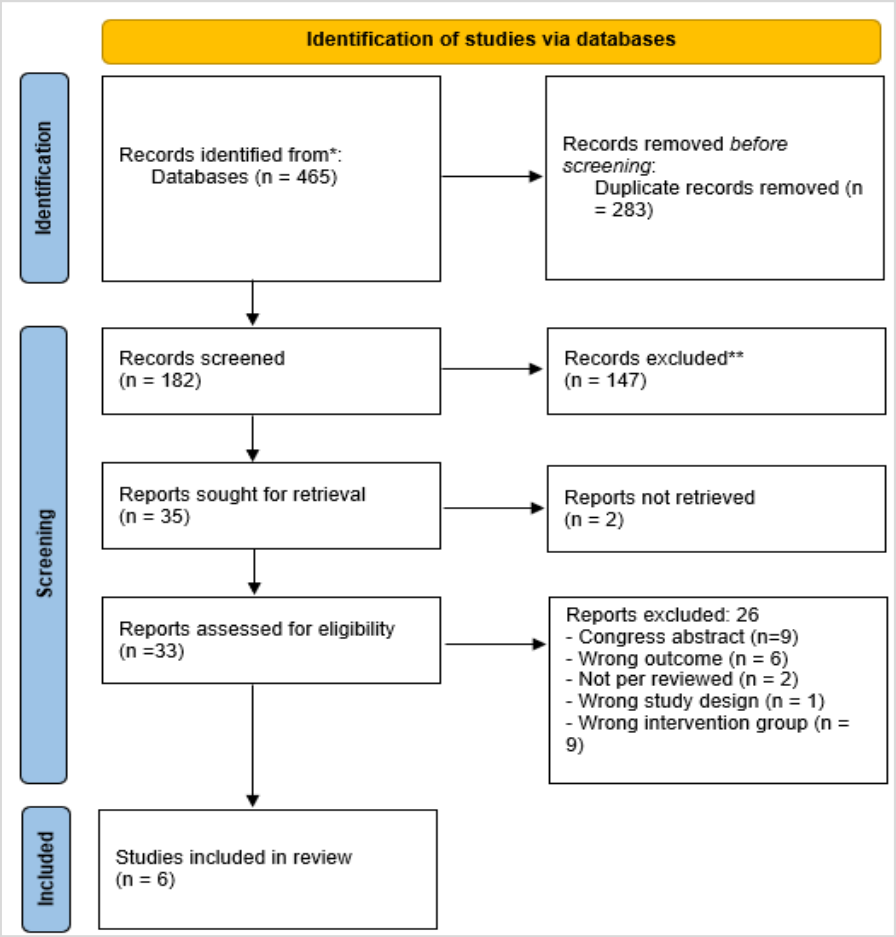

Fig. 1. Flow diagram of study screening and selection

Study Selection

Study selection and screening process was conducted by three independent authors using Rayyan.ai., a web-based software designed to facilitate systematic reviews by enabling efficient screening, collaboration and double-blind screening [12]. Researchers identified studies with reliable information about baseline characteristics; masseter and psoas sarcopenia; mortality rates; functional status after discharge; intensive care unit (ICU) and hospital length of stay; and follow-up times. The primary inclusion criteria for articles were: (1) Studies involving patients with TBI or stroke, (2) studies that used masseter and/or psoas sarcopenia levels as predictors of outcomes, (3) studies reporting on clinical presentation and (4) retrospective and prospective cohort studies, case-control studies. Disagreements were resolved through discussion with a fourth reviewer.

Data extraction

Data was collected by 2 authors via a predefined spreadsheet. The following items were extracted: authors, year of publication, journal, country/region, study design, sample size, mean age, sex, clinical presentation, mean masseter and/or psoas area, admission Glasgow Coma Scale, overall mortality rate, functional status after discharge and ICU/hospital length of stay, findings and conclusions. Information about the included studies can be found in Table 1. Values regarding age, masseter area, psoas area and psoas muscle index were presented as weighted means, as those values were presented as medium values by the included studies.

Table I: Included studies characteristics

Author	Publication year	DOI	Journal name	Country	Study design
CHOA, *et al*	2022	10.1016/j.injury.2022.02.043	Injury	South Korea	Retrospective cohort study
BORIESOSDICK, et al	2023	10.1016/j.jstrokecerebrovasdis.2023.107421	Journal of Stroke and Cerebrovascular Diseases	Germany	Retrospective cohort study
BONATTI, *et al*	2023	10.1177/19714009221098370	The Neuroradiology Journal	Italy	Retrospective observational study
CHO, *et al*	2021	10.3340/jkns.2021.0004	Journal of Korean Neurosurgical Society	South Korea	Retrospective cohort study
UHLICH, *et al*	2018	10.4103/1673-5374.241451	Neural Regeneration Research	USA	Retrospective cohort study
HU, *et al*	2017	10.1089/neu.2017.5422	Journal of Neurotrauma	USA	Retrospective cohort study

Quality assessment

Two independent authors assessed the risk of bias and study quality via the ROBINS-I tool [13]. Also, this systematic review was assessed for methodological quality using the AMSTAR 2 tool [14]. More information can be found in Figure 2 and Supplementary Material. In addition, this article followed the PRISMA checklist for systematic reviews and meta-analysis, illustrated in Supplementary material [15].

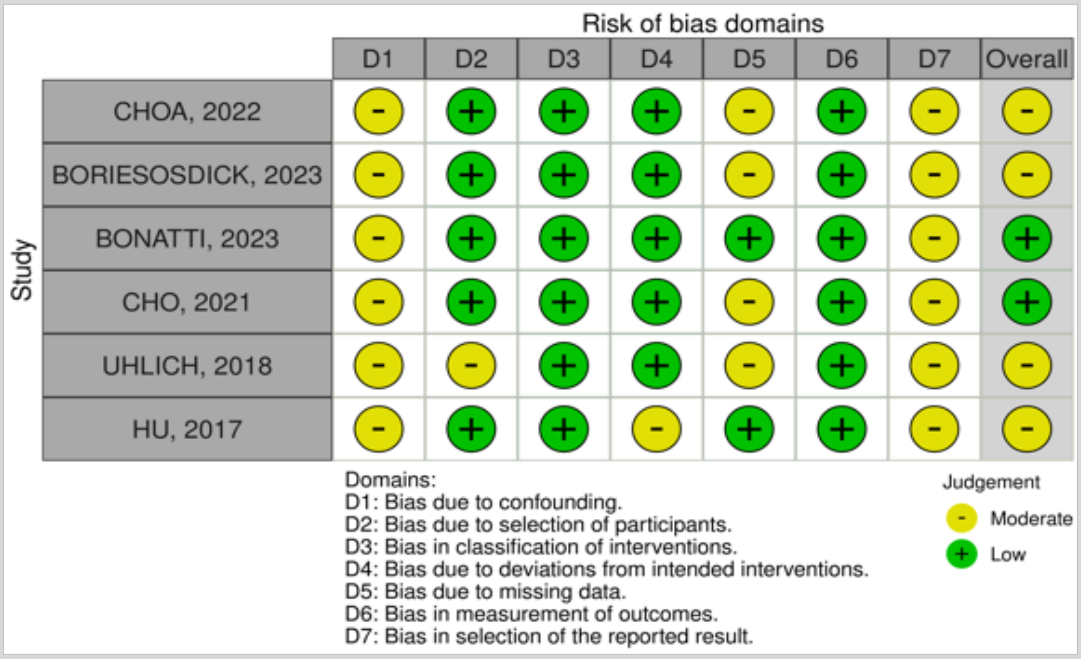

Fig. 2: ROBINS-I assessment tool of included studies

Robins-I risk of bias summary for included studies. Green circles indicate domains judged at low risk of bias, and yellow circles indicate domains judged at intermediate risk of bias. Domains assessed are confounding, selection of participants, classification of interventions, deviations from intended interventions, missing data, measurement of outcomes, and selection of reported studies

Results

Patient information

After the initial review of 465 articles, screening was conducted, resulting in 6 included articles totalling 962 individuals in which approximately 58% were male. The weighted mean for age, masseter area, psoas area and psoas muscle index were 66.30, 4.92, 16.38 and 5.76, respectively. More information can be found in Table 2.

Functional status, ICU and hospital length of stay and mortality outcomes

Regarding mortality rate, all studies have shown an increase in sarcopenic patients, with both analysis (psoas and masseter) being accurate to predict such outcome. Also, there were few available data on ICU and hospital length of stay (LOS), but indirect measures - such as days free of the ICU, days free of ventilator and rates of pneumonia - suggests that there is a relation between the masseter and psoas area with ICU/hospital LOS. Furthermore, functional status was also a related outcome. Studies have shown that neurocritical and sarcopenic patients tend to have a worse Modified Rankin Scale (mRS) and Glasgow Outcome Scale (GOS), in addition to being discharged to a nursing facility. More information about these outcomes can be found in Table 3.

Table II: Patient Characteristics of the Included Studies

Study	Sample size	Male (%)	Mean age (SD)	Masseter area	Mean psoas area (SD)	Mean psoas muscle index (SD)	Admission Glasgow Coma Scale
CHO, *et al*	212	81%	58.7 (±16.6)	N/A	16.3 cm^2 (5.7)	5.73 cm^2/m^2 (1.8)	N/A
BORIESOSDICK, *et al*	189	45%	74.2 (±13.2)	Right: 412.5 mm^2 (±115.8), Left: 420.9 mm^2 (±116.2)	N/A	N/A	N/A
BONATTI, *et al*	166	49%	70 (±13)	4.19 cm^2 (±1.31)	N/A	N/A	N/A
CHO, *et al*	179	82%	58.0 (±16.2)	9.76 cm^2 (±2.50)	16.47 cm^2 (±5.60)	5.80 cm^2/m^2 (±1.75)	N/A
UHLICH, et al	108	N/A	67.4 ± 10.6	4.55 ± 1.25 cm^2 (males) 3.37 ± 1.03 cm^2 (females)	N/A	N/A	N/A
HU, *et al*	108	73%	74.4±11.1	2.61±0.51	N/A	N/A	3 (3-4.5)

This table presents demographic and clinical data from the included studies, including sample size, sex distribution, mean age (with standard deviation), and muscle measurements (masseter area, psoas area, and psoas muscle index). The Admission Glasgow Coma Scale score is also provided where available. N/A: not available; SD: standard deviation

Table III: Mortality, length of stay and functional status.

Study	Mortality rate	ICU/Hospital LOS	Functional status
CHO, et al	23%	21.4 days	58% GOS (1-3)
BORIESOSDICK, et al	43%	N/A	73% mRS ≥ 3
BONATTI, et al	21.7%	N/A	30.7% mRS 3-5
CHO, et al	16.8%	N/A	Mean GOS 3.7
UHLICH, et al	60%	N/A	0% discharged home
HU, et al	80%	2.4±7.6	0% discharged home

Discussion

In our review, we examined six studies that encompassed a total of 962 patients, with approximately 58% being men. The mean age of patients was 66 years. We accurately measured key factors such as the masseter muscle area, averaging 4.92, and the psoas muscle area, with a mean value of 16.38. Furthermore, the psoas muscle index mean value of 5.76. A crucial takeaway from our review is the clear and consistent increase in the prevalence of sarcopenia among the conditions in the population studied.

Both the psoas and masseter muscle analyses show a promising ability to predict outcomes related to sarcopenia. Although our data on ICU and hospital LOS. Were somewhat limited, we observed strong trends in indirect measures like days free of pneumonia that suggest a connection between muscle area measurements and LOS. Overall, these findings underscore the idea that assessing muscle health does not only significantly affect their recovery journey in the hospital.

This study is essential for several important reasons. First, it addresses the urgent issue of sarcopenia, which is primarily caused by the natural process of aging that remains not fully understood and is multifaceted [15]. These include a reduction in the size and quantity of type II muscle fibers, a sedentary lifestyle, obesity, and insulin resistance. Additional contributing factors are lower levels of androgens and growth factors in the serum, insufficient protein intake, and a diminished muscle protein synthesis response following protein meals or resistance training. Understanding these factors is essential, as they significantly impact muscle health and overall metabolic function. This condition is significant for certain groups of patients, especially those receiving neurocritical care. Physicians who evaluate sarcopenia often examine the psoas and masseter muscles using CT scans. These muscles are important markers of overall muscle health and can provide important perception of a patient's functional ability. Early recognizing and monitoring of sarcopenia is essential, as it significantly affects recovery and overall patient outcomes [15,16].

Also, the psoas muscle plays a crucial role in our ability to move and function physically. When this muscle weakens, it can make patients more vulnerable during serious illnesses, which can slow down their recovery process. As well, the masseter muscle, which we rely on for chewing, can give us important guidance about a person's nutritional status and overall health, especially in critical care situations. Keeping an eye on these muscle groups can provide valuable awareness that helps healthcare providers make informed decisions and develop effective strategies for managing patient care [16]. In addition, a previous meta-analysis on psoas muscle morphology by Wang *et al*., demonstrating that a reduction in psoas muscle cross-sectional area was associated with increased in-hospital mortality and long-term complications [17]. This broader perspective underscores the need for standardized sarcopenia definitions in neurocritical care and establishes a foundation for future studies incorporating both craniofacial with moderate to severe trauma. In contrast, our systematic review broadens the scope by evaluating both psoas and masseter sarcopenia in a neurocritical population, encompassing patients with stroke and TBI. By incorporating the masseter muscle, our study provides a more comprehensive assessment of sarcopenia, recognizing its potential impact on not only functional recovery but also nutritional status, which is often overlooked in studies focused solely on limb or core muscle atrophy.

Additionally, our findings highlight the heterogeneity in sarcopenia assessment, with only two of the included studies using the psoas muscle index - a discrepancy not addressed in prior reviews. Unlike Wang *et al*, who primarily analyzed trauma outcomes, our review expands on the critical implications of sarcopenia in neurological conditions, where muscle mass deterioration may influence prolonged ICU stays, ventilator dependence and long-term functional outcomes.

Moreover, the research surrounding sarcopenia, particularly in relation to the masseter and psoas muscles, is marked by significant controversy primarily due to the absence of a unified definition and measurement standards. While compelling evidence highlights these muscles' predictive value in clinical outcomes, the threshold values for sarcopenia remain inconsistent across various studies. This inconsistency limits the ability to make meaningful comparisons and generalizations. Moreover, potential confounding factors, such as neurocritical conditions and comorbidities, can obscure the true impact of sarcopenia, complicating efforts to isolate its effects. This review emphasizes the urgent need for further research to address these critical issues and to develop standardized guidelines for the clinical assessment of these muscle measurements [16,18,19].

In addition, two other systematic review studies similarly assessed the relationship between sarcopenia and critically ill hospitalized patients. Zhang *et al*. analyzed a more heterogeneous population of critically ill patients admitted to the ICU, without specific restriction to neurocritical patients [20]. They included various criteria for sarcopenia (total psoas area, skeletal muscle index, and masseter muscle) and focused on outcomes related to hospital mortality, 30-day, and 1-year mortality. Similar to our study, they observed a significant increase in mortality in critically ill patients with sarcopenia, with an odds ratio (OR) of 2.28 (95% CI: 1.83–2.83). Koh *et al*., included a broader population of neurocritical patients, encompassing individuals with trauma, intracranial aneurysms, ischemic stroke, transient ischemic attack and intracranial stenosis. They analyzed mortality, length of stay, and functional status. Like us, they found that sarcopenia was associated with increased mortality, longer hospitalizations, and worse neurological outcomes, although they did not assess functional scales such as GOS and mRS [21]. Thus, our study stands out by demonstrating that the specific analysis of the masseter and psoas muscles may help predict mortality, hospitalization, and functional status in patients hospitalized for TBI and stroke, as other studies have shown in more generalized populations and through other forms of sarcopenia measurement.

Also, based on our findings, we recommend the following actions for future research and clinical practice: future studies should focus on the intensity of physiotherapeutic therapy and other treatments that reduce the impacts of sarcopenia, in order to gain a better understanding of the real prognosis, based on specific evaluation results of the psoas and masseter muscles in relation to sarcopenia. Moreover, Glasgow Coma Scale register in admission would be helpful. A systematic review conducted by Pisano *et al*.[22] found that the Verbal Glasgow Coma Scale (V-GCS) score was directly linked to outcomes and mortality in cases of TBI. Similarly, it may help to better understand the influence of the results of assessment psoas and masseter of neurocritical patients. Furthermore, younger patients should be included in future research, as younger adults—and even adolescents-can also be sarcopenic [23].

This systematic review has several limitations. First, the small number of included studies (n=6) and relatively modest sample size (962 patients) limit the generalizability of findings and increase the risk of publication bias. Second, all included studies were retrospective, introducing potential selection bias and inconsistencies in patient populations, imaging methodologies, and sarcopenia thresholds. Third, there was considerable heterogeneity in how psoas and masseter sarcopenia were assessed, with only two studies using the psoas muscle index, while others relied on the cross-sectional area, making challenging direct comparisons. Fourth, the absence of standardized cut-off values for sarcopenia further complicates the interpretation of results. Finally, outcome measures such as ICU length of stay and functional status were not consistently reported across studies, limiting the ability to draw strong conclusions about clinical implications. Despite these limitations, this review highlights the prognostic potential of psoas and masseter sarcopenia in neurocritical patients and underscores the need for future prospective studies with standardized methodologies.

In light of the foregoing, both masseter and psoas muscles have been shown to serve as potential predictors of adverse outcomes, with impact on mortality, functional status and hospitalization. Thus, data on neurocritical patients is scarce and this population must be considered in future primary studies. Also, further analysis should compare directly psoas and masseter on different neurological pathologies, such as stroke and TBI.

Declarations

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Conflict of interest

The authors declare that there were no conflicts of interest regarding financial or other interests

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Contributors

IAM: Literature screening and data extraction
LRL: Screening and initial draft
NMS: Data extraction and table generation
HBN: Literature screening
MEBT: Execution of methodological quality and bias assessment
VLR: Initial draft
GLS: Conceptualization; supervised writing, screening, and data extraction; Results review; Final manuscript draft

Ethical Clearance

Not Applicable

Trial details

Not Applicable

Supplementary Material

Figure SI. Methodological quality assessment with the Assessing the Methodological Quality of Systematic Reviews 2 (AMSTAR 2) tool

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