

Association of Appendicular Lean Mass-to-Weight Ratio with Dysphagia Severity in Subacute Stroke

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Introduction

- Sarcopenia is increasingly recognized as a contributing factor to post-stroke dysphagia, where systemic muscle depletion may exacerbate neurologically induced swallowing difficulties.
- However, conventional height-adjusted muscle indices might underestimate relative muscle depletion in patients with sarcopenic obesity.
- The appendicular lean mass-to-weight ratio (ALM/weight) has been suggested as a useful parameter to reflect systemic muscle reserve relative to body mass.
- This study aimed to investigate the association between the ALM/weight ratio and dysphagia severity, measured by the Penetration-Aspiration Scale (PAS), independent of initial neurological deficits in stroke patients.

Methods

- This retrospective study included stroke patients aged ≥ 50 years admitted between September 2023 and December 2025.
- To ensure a homogenous early-recovery cohort, patients who underwent Videofluoroscopic Swallowing Study (VFSS) within 30 days of stroke onset were included.
- To minimize the temporal discrepancy between muscle mass and swallowing evaluation, the interval between Dual-energy X-ray Absorptiometry (DEXA) and VFSS was limited to within 7 days.
- Patients with brainstem lesions were excluded. Dysphagia severity was assessed using the Penetration-Aspiration Scale (PAS).
- Patients were categorized using established Asian cutoffs for sarcopenic obesity (abnormal ALM/weight: $< 29.0\%$ for men, $< 22.9\%$ for women).
- Additionally, a continuous 'sex-normalized ALM/weight ratio' was calculated.
- Initial stroke severity was evaluated using the NIHSS and GCS, and was subsequently adjusted as a confounding variable in the analysis.

Results

- A total of 39 patients were analyzed.
- Patients with an abnormal ALM/weight ratio showed higher PAS scores compared to those in the normal range (2.67 ± 1.74 vs. 1.39 ± 0.78 , $p = 0.013$).
- In the multivariable ordinal logistic regression model adjusted for age, sex, and initial stroke severity, meeting the ALM/weight cutoff remained a significant independent predictor of lower PAS scores ($p = 0.016$).
- Furthermore, the continuous sex-normalized ALM/weight ratio was also significantly associated with the PAS score ($p = 0.006$).
- Initial stroke severity did not reach statistical significance as an independent predictor of PAS in this specific non-brainstem cohort ($p = 0.129$).

Conclusion

The ALM/weight ratio is significantly associated with the PAS score in early subacute stroke patients, independent of initial neurological severity.

Both categorical and sex-normalized continuous analyses suggest that maintaining adequate systemic muscle mass relative to body weight may play an important role in swallowing safety.

Evaluating whole-body composition could be considered a clinically relevant aspect of post-stroke dysphagia rehabilitation.

Table 1. Baseline Characteristics According to ALM/Weight Status

Predictors	Coefficient (β)	Standard Error	z-value	p-value
Model 1: Categorical Approach				
Normal ALM/Weight Ratio ^a	-2.104	0.877	-2.400	0.016*
Age	-0.009	0.051	-0.180	0.857
Sex (Male)	0.960	0.902	1.064	0.287
Initial Stroke Severity (Mod-to-Severe)	1.520	1.003	1.517	0.129
Model 2: Continuous Approach				
Sex-Normalized ALM/Weight Ratio ^b	-12.765	4.612	-2.768	0.006*
Age	-0.014	0.050	-0.274	0.784
Sex (Male)	1.155	0.895	1.290	0.197
Initial Stroke Severity (Mod-to-Severe)	1.075	0.998	1.077	0.281

Note: The dependent variable is the Penetration-Aspiration Scale (PAS) score.

^a Defined as ALM/Weight $\geq 29.0\%$ for men and $\geq 22.9\%$ for women.

^b Calculated as the patient's ALM/Weight divided by their respective sex-specific cutoff.

* $p < 0.05$.

Table 2. Multivariable Ordinal Logistic Regression Analysis for Dysphagia Severity (PAS)

Characteristics	Abnormal ALM/Weight (n = 21)	Normal ALM/Weight (n = 18)	p-value
Age (years), mean \pm SD	75.5 \pm 9.5	66.0 \pm 9.3	0.003*
Sex (Male), n (%)	10 (47.6%)	9 (50.0%)	1.000
BMI (kg/m ²), mean \pm SD	24.7 \pm 4.0	22.2 \pm 3.9	0.055
Onset to VFSS (days), mean \pm SD	16.0 \pm 8.2	18.1 \pm 5.2	0.374
Initial Stroke Severity, n (%)			1.000
- Mild (NIHSS ≤ 4 or GCS 13–15)	5 (23.8%)	4 (22.2%)	
- Moderate to Severe	16 (76.2%)	14 (77.8%)	
PAS Score, mean \pm SD	2.7 \pm 1.7	1.4 \pm 0.8	0.013*

Note: ALM/Weight, Appendicular Lean Mass-to-Weight ratio; BMI, Body Mass Index; VFSS, Videofluoroscopic Swallowing Study; NIHSS, National Institutes of Health Stroke Scale; GCS, Glasgow Coma Scale; PAS, Penetration-Aspiration Scale. p-values were calculated using the independent t-test, Mann-Whitney U test, or Fisher's exact test, as appropriate. * $p < 0.05$.

Figure 1. Association of Appendicular Lean Mass-to-Weight (ALM/Weight) Status with Dysphagia Severity.

(A) Mean Penetration-Aspiration Scale (PAS) scores compared between normal and abnormal ALM/weight categories. (B) Correlation between the continuous sex-normalized ALM/weight ratio and PAS score, showing a significant inverse relationship.

