DOI: 10.4274/gulhane.galenos.2024.24582
Gulhane Med J 2024;66:49-57

Relationship between ultrasonographically assessed biceps brachii muscle mass and complete blood cell and blood chemistry

Nezahat Müge Çatıkkaş

University of Health Sciences Türkiye, Hamidiye Faculty of Medicine; Sancaktepe Şehit Prof. Dr. İlhan Varank Training and Research Hospital, Clinic of Internal Medicine, Division of Geriatrics, İstanbul, Türkiye

Date submitted:
27.12.2023
Date accepted:
25.01.2024
Online publication date:
08.03.2024

Corresponding Author:
Nezahat Müge Çatıkkaş, M.D., University of Health Sciences Türkiye, Hamidiye Faculty of Medicine; Sancaktepe Şehit Prof. Dr. İlhan Varank Training and Research Hospital, Clinic of Internal Medicine, Division of Geriatrics, İstanbul, Türkiye
+90 536 711 12 48
nz444mg@hotmail.com

ORCID:
orcid.org/0000-0003-2494-1625

Keywords: Albumin, biceps brachii, creatinine, laboratory, muscle mass, ultrasonography

ABSTRACT

Aims: Relationships between muscle mass measured using different methods at different sites and several biochemical variables have been reported. The biceps brachii muscle mass can easily be assessed by ultrasonography (USG). This study investigated the relationship between ultrasonographically assessed biceps brachii muscle mass and complete blood cell count and blood chemistry variables in older palliative care patients.

Methods: A cross-sectional observational study was conducted between June 2023 and August 2023 in an institutional palliative care setting. Demographic characteristics, comorbidities, Nutritional Risk Screening-2002 score, feeding route, and pressure ulcers were recorded. Biceps brachii muscle thickness (BBMT) and cross-sectional area (BBCSA) were assessed using USG. The relationship between muscle mass and target laboratory variables was evaluated by correlation and multiple regression analyses.

Results: The study included 214 patients (age, mean±standard deviation: 78.4±9.1 years, female: 55.1%). BBMT was positively correlated with serum albumin (r=0.160, p=0.019) and creatinine (r=0.182, p=0.008) levels. BBCSA was positively correlated with serum albumin level (r=0.216, p=0.001). Controlling for age, sex, malnutrition risk, and C-reactive protein, only serum albumin level was independently associated with BBMT (ß=0.238, p=0.002) and BBCSA (ß=0.258, p<0.001).

Conclusions: This study showed for the first time that serum albumin levels were independently associated with BBMT and BBCSA in older palliative care patients. Multi-center, longitudinal studies on multiple body regions are warranted to generalize these findings.

Introduction

Sarcopenia, characterized by the progressive loss of muscle strength, muscle mass, and/or physical performance (1), increases with aging and leads to increased risks of falls, fractures, disability, prolonged length of hospital stay, rehospitalization, and death, especially in patients with chronic diseases (2,3). Several mechanisms have been identified for sarcopenia, including nutritional deficiencies, insulin resistance, oxidative stress, atherosclerosis, smoking, changes in age-related sex hormones, neuromuscular dysfunction, endocrine abnormalities, chronic inflammation, and inadequate physical activity (4,5).

Because muscle mass is critical in assessing sarcopenia, measurement techniques have attracted great interest. Various imaging modalities, such as computed tomography (CT), magnetic resonance imaging (MRI), dual-energy X-ray absorptiometry (DXA), and bioelectrical impedance analysis (BIA), can predict muscle mass (1). However, these methods

have some limitations in daily practice. Although CT and MRI are the gold standards, they are time-consuming, costly, and require special equipment. CT can also emit radiation. DXA can also cause radiation, cannot be performed at the bedside, and may not always be available in primary care hospitals (3). BIA measurements may be affected by alterations in body water (6). However, the utility of ultrasonography (USG) is promising because it is feasible, inexpensive, portable, and radiation-free, yielding results comparable to CT, MRI, and DXA (7). It can be used at the bedside, especially for bedridden patients in palliative and intensive care units (2). USG is also a valid and reliable tool for assessing muscle mass in older people (7). While most studies conducted on USG have focused on the lower limbs, primarily the rectus femoris and gastrocnemius muscles (8), few studies have investigated the upper limbs (2).

Several markers have been identified in recent years that may be useful for tracking muscle decline. The most widespread indicators are those related to the inflammatory response [e.g., C-reactive protein (CRP), tumor necrosis factor-α, and interleukin-6], biochemical parameters [e.g., albumin, white blood cell (WBC), neutrophil-to-lymphocyte ratio (NLR), platelet (PLT), platelet-to-lymphocyte ratio (PLR), hemoglobin, blood urea nitrogen, creatinine, alanine aminotransferase (ALT), and aspartate aminotransferase (AST)], hormones (e.g., vitamin D and testosterone), oxidative stress markers (e.g., advanced glycation end products and low-density lipoproteins), or antioxidants (e.g., α tocopherol and carotenoids) (4,9-11). Although muscle mass assessed by different methods correlates with various biochemical variables, potential associations between ultrasonographically assessed biceps brachii muscle mass and laboratory variables in the palliative care setting are unknown. Therefore, this study investigated the relationship of ultrasonographically assessed biceps brachii muscle mass with complete blood cell count and blood chemistry variables in older patients receiving palliative care.

Methods

Design, setting, and study population

A cross-sectional, observational study was conducted in the palliative care unit of University of Health Sciences Türkiye, Sancaktepe Şehit Prof. Dr. İlhan Varank Training and Research Hospital, İstanbul, Türkiye, from June 2023 to August 2023. The inclusion criteria were age 60 or older and residing in the palliative unit for at least 24 hours. The exclusion criteria were hemiplegia/quadriplegia, upper limb amputation, contractures, fractures, edema (2), missing relevant medical information (3), and refusal to participate. The study protocol was approved by the University of Health Sciences Türkiye, Sancaktepe Şehit Prof. Dr. İlhan Varank Training and Research Hospital Local Ethics Committee (code: 2022/152, date: 14.12.2022). Patients and/or their carers provided signed informed consent, and the procedures were in accordance with the Declaration of Helsinki.

Study variables

Demographic characteristics and comorbidities were collected from patient records. The Charlson Comorbidity Index (CCI) score, a predictor of mortality, with higher scores indicating a higher risk for mortality and more severe comorbid conditions, was calculated as previously defined (12-14). Nutritional status was assessed by Nutritional Risk Screening-2002 (NRS-2002), a validated tool in Turkish (15,16). A score of ≥3 indicates malnutrition risk (MNR). The feeding route was recorded as oral, enteral (nasogastric tube/percutaneous endoscopic gastrostomy tube), or parenteral. Pressure ulcers were classified using the system proposed by the European Pressure Ulcer Advisory Panel/Pan Pacific Pressure Injury Alliance/National Pressure Ulcer Advisory Panel (17).

After 8 h of fasting, blood samples were collected at 08:00-A.M. Complete blood cell count variables included WBC, neutrophil, lymphocyte, hemoglobin, hematocrit, mean corpuscular volume, and PLT levels. NLR was calculated by dividing the neutrophil count by the lymphocyte count. PLR was calculated by dividing the PLT count by the lymphocyte count. Blood chemistry variables included glucose, HbA1c, sodium, potassium, magnesium, calcium, phosphorus, albumin, urea, creatinine, uric acid, alkaline phosphatase, gamma-glutamyl transferase, AST, ALT, lactate dehydrogenase, CRP, procalcitonin, erythrocyte sedimentation rate, thyroid-stimulating hormone, vitamin B12, folate, and 25 (OH) vitamin D levels. The albumin/creatinine ratio was calculated by dividing serum albumin level by creatinine level. The estimated glomerular filtration rate was calculated using the Chronic Kidney Disease Epidemiology Collaboration equation. All measurements were performed using Mindray BC6800, Alifax Test 1, and Roche Cobas 6000 autoanalyzers.

Muscle mass measurement (muscle thickness and cross-sectional area)

The biceps brachii muscle mass was assessed using USG. The same clinician (NMC) who was blinded to the patient's medical condition performed the measurements using a linear probe of 7.5 MHz with 5 cm width in B mode (Philips Affiniti 50). Biceps brachii MT (BBMT) and CSA (BBCSA) were measured with the patients lying down and the limbs outstretched and relaxed. After a 5-minute rest, three consecutive measurements were obtained, and the mean value was recorded. The biceps brachii muscle was determined at the center point of the distance between the olecranon and acromion. The probe was orientated vertically to the horizontal axis of the humerus at a minimum pressure. The layer between the superficial and deep fascias of the biceps brachii muscle was referred to as muscle thickness in millimeters (mm), whereas the area between the superficial and deep fascias of the biceps brachii muscle was expressed as the cross-sectional area in mm^2 (Figure 1).

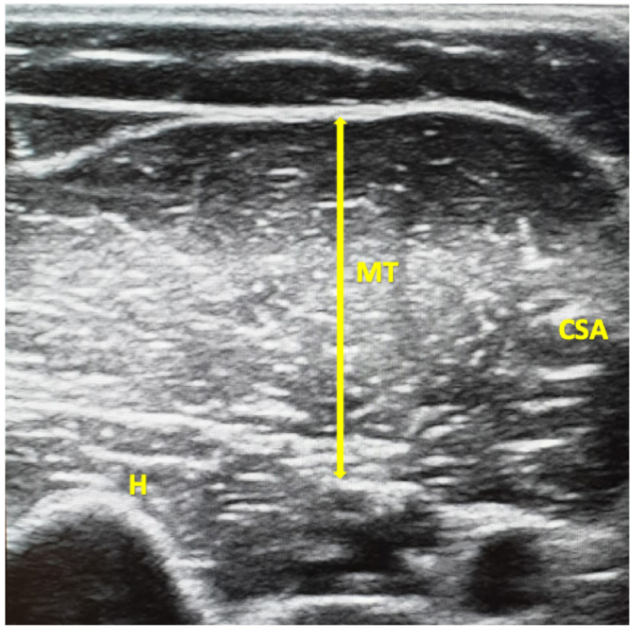

Figure 1. Transverse ultrasonographic image of biceps brachii muscle
CSA: Cross-sectional area, H: Humerus, MT: Muscle thickness

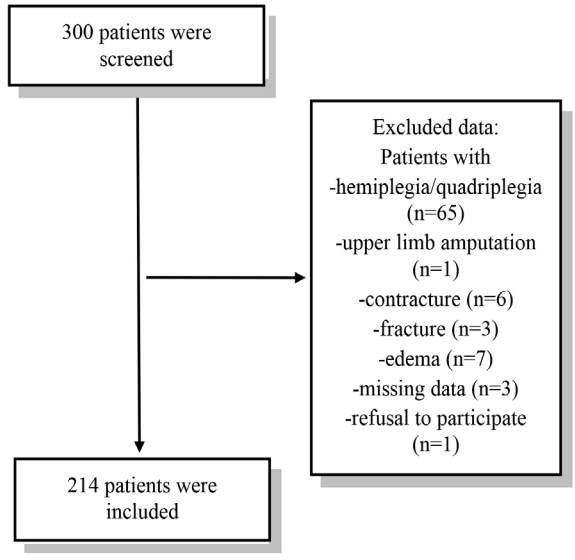

Figure 2. Flow chart of patient selection

To check intraobserver reliability, intraclass correlation coefficients (ICCs) were calculated by taking two images obtained 15 min apart from 15 healthy volunteers. The ICCs for BBMT and BBCSA were 0.95 and 0.99, respectively.

Statistical Analysis

The Statistical Package for Social Sciences version 21 for Windows (IBM Corp., Armonk, NY) was used to perform statistical analyses. The Kolmogorov-Smirnov test was used to test the data distribution. Continuous variables are presented as mean±standard deviation (SD) for those with a normal distribution or median (minimum-maximum) for those without a normal distribution. Categorical variables are presented as numbers and percentages [n (%)]. Correlations between biceps brachii muscle mass and complete blood cell count and blood chemistry variables were tested using Pearson's or Spearman's rho correlation coefficients. Unadjusted (Model 1) and multiple regression analyses were performed to explore the factors independently associated with BBMT and BBCSA. Model 2 was adjusted for age and gender. Model 3 included the variables in Model 2 and MNR. Model 4 included CRP in addition to the variables in Model 3. A p-value of <0.05 was considered statistically significant.

Results

Patient selection

There were 300 eligible patients during the study period. Following excluding patients with hemiplegia/quadriplegia (n=65), upper limb amputation (n=1), contracture (n=6), fracture (n=3), edema (n=7), missing data (n=3), and unwillingness to participate (n=1) the study included 214 patients in the final analysis (Figure 2).

Demographic and clinical variables

The mean age of the patients included in the study was 78.4±9.1 years and 55.1% were female. The majority of patients had hypertension (60.3%), cerebrovascular accident (36.9%), diabetes mellitus (32.2%), and dementia (31.3%). The median number of diseases was three (minimum-maximum: 0-8) and the median CCI score was four (minimum-maximum: 0-15). The mean±SD NRS-2002 score was 5±1.6, 93% had MNR, and 51.5% were on enteral nutrition. Of the included patients, 55.1% had pressure ulcers. Table 1 shows the characteristics of the study population.

Correlation analyses

BBMT positively correlated with serum albumin (r=0.160, p=0.019) and creatinine serum (r=0.182, p=0.008) levels, whereas BBCSA positively correlated only with serum albumin level (r=0.216, p=0.001) (Table 2).

Multiple regression analyses

Multiple regression analysis showed that after adjusting for age, sex, MNR, and CRP, albumin level was independently associated with both BBMT (ß=0.238, p=0.002) and BBCSA (ß=0.258, p<0.001) (Tables 3, 4).

Table 1. Characteristics of the study population (n=214)	
Age, years, mean±SD	78.4±9.1
Sex, female, n (%)	118 (55.1)
Comorbidities, n (%)	
Hypertension	129 (60.3)
Cerebrovascular accident	79 (36.9)
Diabetes mellitus	69 (32.2)
Dementia	67 (31.3)
Malignancy	59 (27.6)
Coronary artery disease	39 (18.2)
Chronic heart failure	35 (16.4)
Chronic obstructive pulmonary disease	33 (15.4)
Number of diseases, median (min.-max.)	3 (0-8)
Charlson Comorbidity Index score, median (min.-max.)	4 (0-15)
Nutritional Risk Screening-2002 score, mean±SD	5±1.6
Malnutrition risk, n (%)	199 (93)
Feeding routes, n (%)	
Oral	
Enteral	90 (42)
Nasogastric tube	110 (51.5)
Percutaneous endoscopic gastrostomy	74 (34.7)
Parenteral	36 (16.8)
Pressure injuries, n (%)	14 (6.5)
Complete blood cell and blood chemistry	118 (55.1)
White blood cell, µL, median (min.-max.)	8.370 (890-31.430)
Neutrophil, µL, median (min.-max.)	6.075 (780-23.500)
Lymphocyte, µL, median (min.-max.)	1.320 (60-6.350)
Neutrophil-to-lymphocyte ratio§	4.190 (1-33.470)
Hemoglobin, g/dL, mean±SD	9.7±1.6
Hematocrit, %, mean±SD	30.4±5.1
Mean corpuscular volume, fL, mean±SD	88.4±7
Platelet, µL, median (min.-max.)	238.500 (14.000-650.000)
Platelet-to-lymphocyte ratio§	153.792 (80-674.698)
C-reactive protein, mg/L, median (min.-max.)	43.5 (0.7-269.7)
Procalcitonin, median (min.-max.)	0.1 (0.04-100)
Erythrocyte sedimentation rate, mm/h, median (min.-max.)	52 (2-120)
Glucose, g/dL, median (min.-max.)	117.3 (68.4-385.8)
Sodium, mmol/L, mean±SD	136.9±5.8
Potassium, mmol/L, mean±SD	4±0.6
Magnesium, mg/dL, mean±SD	1.8±0.3
Calcium, mg/dL, mean±SD	8.5±1.1
Phosphorus, mg/dL, mean±SD	3.1±0.9
Albumin, g/L, mean±SD	28±5.8
Urea, mg/dL, median (min.-max.)	52 (13-299)
Creatinine, mg/dL, median (min.-max.)	0.8 (0.2-8.7)
Albumin/creatinine ratio, g/mmol, median (min.-max.)	36 (2.4-128.7)
Uric acid, mg/dL, median (min.-max.)	4.7 (0.8-18.5)
Estimated glomerular filtration rate, mL/min/1.73 m^2, median (min.-max.)	85.6 (5.2-171.9)
Alkaline phosphatase, U/L, median (min.-max.)	89.5 (12-1.603)
Gamma-glutamyl transferase, U/L, median (min.-max.)	32 (3-1.041)
Aspartate aminotransferase, U/L, median (min.-max.)	19.6 (5-393)
Alanine aminotransferase, U/L, median (min.-max.)	14 (3-147)
Lactate dehydrogenase, U/L, median (min.-max.)	257 (38-1.561)
Thyroid-stimulating hormone, mIU/L, median (min.-max.)	1.5 (0.005-37.6)
Vitamin B12, pmol/L, median (min.-max.)	545 (128-2.000)
Folate, µg/L, median (min.-max.)	6.1 (0.8-20)
25 (OH) vitamin D, ng/mL, median (min.-max.)	12.8 (3-144)
Muscle mass measures	
Biceps brachii muscle thickness, mm, mean±SD	14±3.4
Biceps brachii cross-sectional area, mm^2, mean±SD	42±10.8

SD: Standard deviation, min.-max.: Minimum-maximum

Table 2. Correlations coefficients between biceps brachii muscle mass and complete blood cell count and blood chemistry variables

Variable	BBMT	BBCSA
White blood cell	r=-0.089, p=0.195	r=-0.068, p=0.321
Neutrophil	r=-0.086, p=0.210	r=-0.065, p=0.348
Lymphocyte	r=-0.017, p=0.803	r=0.019, p=0.787
Neutrophil-to-lymphocyte ratio	r=-0.080, p=0.245	r=-0.105, p=0.127
Hemoglobin	r=0.073, p=0.2837	r=0.113, p=0.100
Hematocrit	r=0.051, p=0.461	r=0.82, p=0.234
Mean corpuscular volume	r=0.096, p=0.163	r=0.095, p=0.164
Platelet	r=-0.031, p=0.652	r=-0.004, p=0.957
Platelet-to-lymphocyte ratio	r=0.012, p=0.865	r=0.036, p=0.600
C-reactive protein	r=0.001, p=0.989	r=-0.021, p=0.758
Procalcitonin	r=-0.085, p=0.218	r=-0.060, p=0.384
Erythrocyte sedimentation rate (mm/h)	r=-0.056 p=0.414	r=-0.105, p=0.125
Glucose	r=-0.041, p=0.549	r=0.011, p=0.868
Sodium	r=-0.060, p=0.380	r=-0.098, p=0.151
Potasium	r=0.053, p=0.444	r=0.035, p=0.615
Magnesium	r=-0.053, p=0.443	r=-0.019, p=0.779
Calcium	r=0.132, p=0.054	r=0.090, p=0.191
Phosphorus	r=0.131, p=0.055	r=0.024, p=0.728
Albumin	r=0.160, p=0.019*	r=0.216, p=0.001*
Urea	r=-0.060, p=0.381	r=-0.085, p=0.213
Creatinine	r=0.182, p=0.008*	r=0.050, p=0.467
Albumin/creatinine ratio	r=-0.105, p=0.127	r=-0.120, p=0.081
Uric acid	r=0.071, p=0.301	r=0.043, p=0.532
Estimated-glomerular filtration rate	r=-0.077, p=0.329	r=-0.018, p=0.821
Alkaline phosphatase	r=0.033, p=0.634	r=0.068, p=0.324
Gamma-glutamyl transferase	r=0.033, p=0.635	r=0.058, p=0.399
Aspartate aminotransferase	r=0.064, p=0.350	r=-0.051, p=0.454
Alanine aminotransferase	r=0.088, p=0.198	r=0.047, p=0.496
Lactate dehydrogenase	r=0.076, p=0.267	r=0.047, p=0.491
Thyroid-stimulating hormone	r=0.052, p=0.448	r=-0.003, p=0.962
Vitamin B12	r=-0.043, p=0.527	r=-0.118, p=0.084
Folate	r=-0.037, p=0.590	r=-0.032, p=0.642
25 (OH) vitamin D	r=0.018, p=0.788	r=-0.063, p=0.356

*p<0.05.
BBMT: Biceps brachii muscle thickness, BBCSA: Biceps brachii cross-sectional area

Discussion

This study showed a positive correlation between BBMT and serum albumin and creatinine levels, whereas BBCSA positively correlated only with serum albumin levels. Serum albumin level was the only parameter independently associated with BBMT and BBCSA in older palliative care patients.

Several studies have suggested that serological tests could serve as diagnostic markers for sarcopenia. A recent study reported higher PLT counts and PLT-to-WBC ratios in sarcopenic patients (4). Another study showed a higher AST-to-ALT ratio in middle-aged and older adults with sarcopenia (11).

Table 3. Multivariate multiple regression analysis for the independently associated factors of biceps brachii muscle thickness

Model	Variable	Unstandardized coefficients		Standardized coefficients	t	Significance	95% confidence interval	
		Beta	Standard error	Beta			Lower bound	Upper bound
1	Albumin level	0.013	0.004	0.214	3.161	**0.002**	0.005	0.021
	Creatinine level	0.043	0.027	0.109	1.608	0.109	-0.010	0.096
2	Age, years	0.001	0.003	0.014	0.205	0.838	-0.005	0.006
	Sex, female	0.221	0.048	0.317	4.564	**<0.001**	0.125	0.316
	Albumin level	0.013	0.004	0.217	3.358	**0.001**	0.005	0.020
	Creatinine level	0.027	0.026	0.068	1.034	0.302	-0.024	0.078
3	Age, years	0.001	0.003	0.016	0.223	0.824	-0.005	0.006
	Sex, female	0.222	0.049	0.318	4.562	**<0.001**	0.126	0.318
	Albumin level	0.013	0.004	0.219	3.361	**0.001**	0.005	0.021
	Creatinine level	0.027	0.026	0.068	1.034	0.302	-0.024	0.078
	Malnutrition risk	0.024	0.087	0.018	0.273	0.785	-0.149	0.196
4	Age, years	0.001	0.003	0.018	0.264	0.792	-0.005	0.006
	Sex, female	0.219	0.049	0.314	4.458	**<0.001**	0.122	0.315
	Albumin level	0.014	0.004	0.238	3.163	**0.002**	0.005	0.023
	Creatinine level	0.026	0.026	0.065	0.993	0.322	-0.025	0.077
	Malnutrition risk	0.030	0.088	0.022	0.337	0.736	-0.144	0.204
	C-reactive protein level	<0.001	<0.001	0.039	0.514	0.607	-0.001	0.001

Dependent variable: biceps brachii muscle thickness, independent variables: albumin level, creatinine level, age, sex, malnutrition risk, and C-reactive protein.
Model 1: unadjusted, Model 2: adjusted for age and sex, Model 3: adjusted for age, sex, and malnutrition risk, Model 4: adjusted for age, sex, malnutrition risk, and C-reactive protein

Table 4. Multivariate multiple regression analysis for the independently associated factors of biceps brachii cross-sectional area

Model	Variables	Unstandardized coefficients		Standardized coefficients	t	Significance	95% confidence interval	
		Beta	Standard error	Beta			Lower bound	Upper bound
1	Albumin level	0.040	0.012	0.216	3.220	**0.001**	0.015	0.064
2	Age, years	0.005	0.008	0.044	0.654	0.514	-0.010	0.021
	Sex, female	0.851	0.145	0.392	5.885	**<0.001**	0.566	1.136
	Albumin level	0.042	0.012	0.225	3.619	**<0.001**	0.019	0.064
3	Age, years	0.006	0.008	0.049	0.728	0.468	-0.010	0.021
	Sex, female	0.862	0.145	0.398	5.948	**<0.001**	0.577	1.148
	Albumin level	0.043	0.012	0.231	3.693	**<0.001**	0.020	0.065
	Malnutrition risk	0.281	0.264	0.067	1.065	0.288	-0.239	0.802
4	Age, years	0.006	0.008	0.052	0.780	0.436	-0.009	0.022
	Sex, female	0.848	0.146	0.391	5.788	**<0.001**	0.559	1.136
	Albumin level	0.048	0.013	0.258	3.554	**<0.001**	0.021	0.074
	Malnutrition risk	0.307	0.267	0.073	1.152	0.251	-0.218	0.833
	C-reactive protein level	0.001	0.001	0.055	0.745	0.457	-0.002	0.004

Dependent variable: biceps brachii cross-sectional area, independent variables: albumin level, age, sex, malnutrition risk, and C-reactive protein.
Model 1: unadjusted, Model 2: adjusted for age and sex, Model 3: adjusted for age, sex, and malnutrition risk, Model 4: adjusted for age, sex, malnutrition risk, and C-reactive protein

NLR and PLR as systemic inflammatory response parameters were reported as predictors of sarcopenia among gastric cancer patients (18). Indeed, numerous studies have established an independent inverse relationship between muscle mass and inflammatory markers. Serum albumin is a negative acute phase protein that may indicate not only inflammatory status but also nutritional status. A positive relationship between serum albumin level and animal protein intake has been reported, and hypoalbuminemia has been proposed as a predictor of all-cause mortality, postoperative complications, and cardiovascular disease (19-21). In a study by Chen et al. (22), serum albumin levels were positively correlated with muscle mass in males but negatively correlated with muscle mass in females, whereas another study reported reduced total protein and albumin levels in patients with sarcopenia compared with controls (23). In a recent study on the severity of sarcopenia in patients with liver cirrhosis, the mid-upper arm and mid-thigh ultrasonographic muscle thicknesses on both sides were positively correlated with serum albumin, bilirubin, and creatinine levels and international normalized ratio (3). In a more recent study, higher serum albumin levels were associated with higher temporal and masseter muscle thickness in patients with large vessel occlusion after endovascular thrombectomy (24). Serum albumin levels and muscle mass were negatively correlated with inflammation and positively correlated with adequate nutrition. In the current study, in line with the literature, both BBMT and BBCSA were positively correlated and independently associated with serum albumin levels, regardless of age, sex, nutrition, and inflammation status. Ninety-eight percent of creatinine is stored in muscles (10). Although its production may depend on muscle quantity/quality, its measurement is also sensitive to impaired renal function, which restricts its utility in assessing muscle mass (10). Even so, circulating creatinine may still serve as an alternative to estimate muscle mass (25). In the current study, BBMT was positively correlated with serum creatinine levels, a finding that is consistent with the literature. Nevertheless, there was no correlation between muscle mass and complete blood cell counts and blood chemistry variables other than serum albumin and creatinine levels, which may be caused by the altered characteristics of muscle fibers and other comorbidities among older patients receiving palliative care.

The judgment of muscle strength and physical performance is challenging in palliative care patients with severe dementia, delirium, reduced cooperation, and immobilization. Therefore, muscle mass measurement is preferable in hospitalized palliative patients. USG may allow clinicians to monitor muscle mass quickly and cheaply, such as muscle thickness, cross-sectional area, pennation angle, fascicle length, and echogenicity (8). However, upper limb muscles have received less interest so far than lower limbs because lower limb muscles are measured more easily and are more relevant to mobilization and activities of daily living than the trunk or skull muscles (26). In addition, senescence-related volumetric alterations in the upper limb muscles may also limit their utility in assessing muscle mass (27). However, in the clinical setting, different authors have linked upper limb muscles with handgrip strength (28), DXA-assessed muscle mass (29), CT-assessed muscle mass (30), sarcopenia (2), and mortality (31). In a recent study, upper limb muscle thickness was correlated with upper limb muscle cross-sectional area, quadriceps femoris muscle thickness, and rectus femoris muscle cross-sectional area, allowing screening for low muscularity during intensive care unit admission (32). Nevertheless, data on the relationship between ultrasonographically measured upper limb muscles and laboratory values in older palliative care patients are insufficient.

The NRS-2002 tool has been validated in hospitalized patients (33). In the current study, the average NRS-2002 score was 5±1.6, the MNR rate was 93%, and 51.5% had enteral nutrition. In a recent study among geriatric palliative care patients, the mean±SD NRS-2002 score was 4±1, the MNR rate was 93.9%, and 58.3% were on enteral feeding (34). In another study comparing the mini-nutritional assessment, NRS-2002, and Global Leadership Initiative on Malnutrition criteria in hospitalized palliative care patients, 93.2% were found to be at risk of malnutrition based on the NRS-2002 test (35). In this context, the results obtained in this study are consistent with the literature.

Pressure ulcers are among the indicators of quality care provision (36-38). The prevalence of pressure ulcers varies in the literature. Although the prevalence ranges between 3% and 14% for inpatients, this rate can reach 70% in certain patient groups. In a systematic review of pressure ulcers in patients receiving palliative care, the overall prevalence was 12.4%, ranging from 9.9% to 54.7% (39). In a more recent study, 42% of hospitalized palliative care patients had pressure ulcers (40). In the current study, 55.1% of patients had pressure ulcers, which could be attributed to advanced age, malnutrition, comorbidities, and previous hospitalizations.

Study Limitations

This study has some limitations. The study focused only on the biceps brachii, and muscle quality measures were unavailable. Causality could not be determined because of the cross-sectional design, and the results may not be generalized to other settings, given the unique characteristics of palliative care patients. In contrast, prospective patient enrollment and the inclusion of a variety of laboratory values in older palliative care patients were the major strengths.

Conclusion

In conclusion, this study revealed that serum albumin levels were independently associated with BBMT and BBCSA in older

palliative care patients. There is a gap in the literature regarding the potential associations of ultrasonographically assessed biceps brachii muscle mass with complete blood cell counts and blood chemistry in older palliative patients. Ultrasonographically assessed biceps brachii muscle mass may serve as a simple and reliable marker of muscle health and nutritional status in patients receiving palliative care. However, further multi-center, longitudinal studies that include multiple body regions are warranted to generalize the observed findings.

Ethics

Ethics Committee Approval: The study protocol was approved by the University of Health Sciences Türkiye, Sancaktepe Şehit Prof. Dr. İlhan Varank Training and Research Hospital Local Ethics Committee (code: 2022/152, date: 14.12.2022).

Informed Consent: All patients and/or their formal caregivers provided signed informed consent.

Financial Disclosure: The author declared that this study received no financial support.

References

1. Cruz-Jentoft AJ, Bahat G, Bauer J, et al. Writing Group for the European Working Group on Sarcopenia in Older People 2 (EWGSOP2), and the Extended Group for EWGSOP2. Sarcopenia: revised European consensus on definition and diagnosis. Age Ageing. 2019;48:16-31.
2. Li S, Li H, Hu Y, et al. Ultrasound for Measuring the Cross-Sectional Area of Biceps Brachii Muscle in Sarcopenia. Int J Med Sci. 2020;17:2947-2953.
3. Nakamura A, Yoshimura T, Sato T, Ichikawa T. Diagnosis and Pathogenesis of Sarcopenia in Chronic Liver Disease Using Liver Magnetic Resonance Imaging. Cureus. 2022;14:e24676.
4. Gholizade M, Farhadi A, Marzban M, et al. Association between platelet, white blood cell count, platelet to white blood cell ratio and sarcopenia in community-dwelling older adults: focus on Bushehr Elderly Health (BEH) program. BMC Geriatr. 2022;22:300.
5. Lu Y, Karagounis LG, Ng TP, et al. Systemic and Metabolic Signature of Sarcopenia in Community-Dwelling Older Adults. J Gerontol A Biol Sci Med Sci. 2020;75:309-317.
6. Catikkas NM, Safer U. Bioelectrical impedance analysis: Caution should be needed to avoid misinterpretation. Clin Nutr. 2023;42:2289-2290.
7. Nijholt W, Scafoglieri A, Jager-Wittenaar H, Hobbelen JSM, van der Schans CP. The reliability and validity of ultrasound to quantify muscles in older adults: a systematic review. J Cachexia Sarcopenia Muscle. 2017;8:702-712.
8. Ticinesi A, Meschi T, Narici MV, Lauretani F, Maggio M. Muscle Ultrasound and Sarcopenia in Older Individuals: A Clinical Perspective. J Am Med Dir Assoc. 2017;18:290-300.
9. Calvani R, Marini F, Cesari M, et al. Biomarkers for physical frailty and sarcopenia: state of the science and future developments. J Cachexia Sarcopenia Muscle. 2015;6:278-286.
10. Gao H, Wang J, Zou X, Zhang K, Zhou J, Chen M. High blood urea nitrogen to creatinine ratio is associated with increased risk of sarcopenia in patients with chronic obstructive pulmonary disease. Exp Gerontol. 2022;169:111960.
11. He Y, Ding F, Yin M, et al. High Serum AST/ALT Ratio and Low Serum INS*PA Product Are Risk Factors and Can Diagnose Sarcopenia in Middle-Aged and Older Adults. Front Endocrinol (Lausanne). 2022;13:843610.
12. Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. J Chronic Dis. 1987;40:373-383.
13. Beddhu S, Bruns FJ, Saul M, Seddon P, Zeidel ML. A simple comorbidity scale predicts clinical outcomes and costs in dialysis patients. Am J Med. 2000;108:609-613.
14. Das M, Bardakci O, Akdur G, et al. Prediction of mortality with Charlson Comorbidity Index in super-elderly patients admitted to a tertiary referral hospital. Cukurova Medical Journal. 2022;47:199-207.
15. Kondrup J, Allison SP, Elia M, et al. ESPEN guidelines for nutrition screening 2002. Clin Nutr. 2003;22:415-421.
16. Bolayır B. Hospitalize Hastalarda Nutrisyonel Değerlendirme Testi NRS-2002'nin (Nutritional Risk Screening -2002) Geçerlilik ve Güvenilirliğinin Değerlendirilmesi. 2014.
17. Kottner J, Cuddigan J, Carville K, et al. Prevention and treatment of pressure ulcers/injuries: The protocol for the second update of the International Clinical Practice Guideline 2019. J Tissue Viability. 2019;28:51-58.
18. Lin J, Zhang W, Huang Y, et al. Sarcopenia is associated with the neutrophil/lymphocyte and platelet/lymphocyte ratios in operable gastric cancer patients: a prospective study. Cancer Manag Res. 2018;10:4935-4944.
19. Kurata H, Meguro S, Abe Y, et al. Dietary protein intake and all-cause mortality: results from The Kawasaki Aging and Wellbeing Project. BMC Geriatr. 2023;23:479.
20. Goodrose-Flores C, Bonn SE, Klasson C, Frankling MH, Lagerros YT, Björkhem-Bergman L. Appetite and its association with mortality in patients with advanced cancer - a Post-hoc Analysis from the Palliative D-study. BMC Palliat Care. 2023;22:159.
21. Ovwasa H, Aiwuyo HO, Okoye OA, et al. Risk Assessment of Pre-dialysis Chronic Kidney Disease (CKD) Patients for Cardiovascular Disease (CVD) in a Tertiary Hospital in Nigeria: A Case-Controlled Cross-Sectional Study. Cureus. 2023;15:e36725.
22. Chen Z, Song C, Yao Z, Sun J, Liu W. Associations between albumin, globulin, albumin to globulin ratio and muscle mass in adults: results from the national health and nutrition examination survey 2011-2014. BMC Geriatr. 2022;22:383.
23. Yin M, Zhang H, Liu Q, et al. Diagnostic Performance of Clinical Laboratory Indicators With Sarcopenia: Results From the

West China Health and Aging Trend Study. Front Endocrinol (Lausanne). 2021;12:785045. Erratum in: Front Endocrinol (Lausanne). 2022;13:852295.

24. Yang SM, Wu HW, Lin YH, Lai TJ, Lin MT. Temporalis and masseter muscle thickness as predictors of post-stroke dysphagia after endovascular thrombectomy. Eur J Radiol. 2023;165:110939.
25. Tang T, Xie L, Hu S, et al. Serum creatinine and cystatin C-based diagnostic indices for sarcopenia in advanced non-small cell lung cancer. J Cachexia Sarcopenia Muscle. 2022;13:1800-1810.
26. Fu H, Wang L, Zhang W, Lu J, Yang M. Diagnostic test accuracy of ultrasound for sarcopenia diagnosis: A systematic review and meta-analysis. J Cachexia Sarcopenia Muscle. 2023;14:57-70.
27. Leigheb M, de Sire A, Colangelo M, et al. Sarcopenia Diagnosis: Reliability of the Ultrasound Assessment of the Tibialis Anterior Muscle as an Alternative Evaluation Tool. Diagnostics (Basel). 2021;11:2158.
28. Abe T, Counts BR, Barnett BE, Dankel SJ, Lee K, Loenneke JP. Associations between Handgrip Strength and Ultrasound-Measured Muscle Thickness of the Hand and Forearm in Young Men and Women. Ultrasound Med Biol. 2015;41:2125-2130.
29. Abe T, Fujita E, Thiebaud RS, Loenneke JP, Akamine T. Ultrasound-Derived Forearm Muscle Thickness Is a Powerful Predictor for Estimating DXA-Derived Appendicular Lean Mass in Japanese Older Adults. Ultrasound Med Biol. 2016;42:2341-2344.
30. Arai Y, Nakanishi N, Ono Y, et al. Ultrasound assessment of muscle mass has potential to identify patients with low muscularity at intensive care unit admission: A retrospective study. Clin Nutr ESPEN. 2021;45:177-183.
31. Catikkas NM, Binay Safer V. Biceps brachii muscle cross-sectional area measured by ultrasonography is independently associated with one-month mortality: A prospective observational study. J Clin Ultrasound. 2023;51:1512-1521.
32. Nakanishi N, Inoue S, Ono Y, et al. Ultrasound-based upper limb muscle thickness is useful for screening low muscularity during intensive care unit admission: A retrospective study. Clin Nutr ESPEN. 2023;57:569-574.
33. Young AM, Kidston S, Banks MD, Mudge AM, Isenring EA. Malnutrition screening tools: comparison against two validated nutrition assessment methods in older medical inpatients. Nutrition. 2013;29:101-106.
34. Yuruyen M, Polat O, Denizli BO, Cirak M, Polat H. Survival and factors affecting the survival of older adult patients in palliative care. Ir J Med Sci. 2023;192:1561-1567.
35. Oztin H, Ozturk I, Oymak B. GLIM criteria for the evaluation of nutrition in palliative care patients, a comparison of MNA-SF and NRS-2002. J Health Sci Med 2021;4:488-492.
36. Young T, Furtado K, Alves P. Health Related Quality of Life (HRQOL) implications for people with pressure ulcers. In: Romanelli M, Clark M, Gefen A, Ciprandi G, et al. Science and practice of pressure ulcer management. Springer; 2018:79-87.
37. Artico M, Piredda M, D'Angelo D, et al. Prevalence, incidence and associated factors of pressure injuries in hospices: A multicentre prospective longitudinal study. Int J Nurs Stud. 2020;111:103760.
38. Gurun P, Ceylan S, Guner M, Bas AO, Halil MG. Closure of pressure injury and mortality in internal medicine wards. Eur Geriatr Med. 2023;14:373-380.
39. Ferris A, Price A, Harding K. Pressure ulcers in patients receiving palliative care: A systematic review. Palliat Med. 2019;33:770-782. Erratum in: Palliat Med. 2020;34:969.
40. Durak A, Binay Safer V, Catikkas NM. The relationship between pressure injuries and ultrasonographically measured rectus femoris muscle thickness. J Tissue Viability. 2023:S0965-206X(23)00139-0.