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Determination of Nutritional Status, Biochemical Parameters and Stroke Severity in Acute Ischemic Stroke Patients: A Cross-Sectional Study

Akut İskemik İnme Hastalarında Beslenme Durumunun, Biyokimyasal Parametrelerin ve İnme Şiddetinin Belirlenmesi: Kesitsel Bir Çalışma

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Abstract

Nutritional problems and nutritional deficiencies resulting from impaired consciousness, dysphagia, fatigue and perceptual disturbances are frequently observed in patients with ischemic stroke following an acute stroke. Weight loss in patients with dysphagia can often lead to malnutrition. This study was conducted to determine the severity of stroke and nutritional status in patients with acute ischemic stroke and to determine the risk of malnutrition. In this study, the nutritional status of patients with ischemic stroke was assessed with NRI and NRS 2002 and some biochemical parameters from the patient's file were examined. All patients had moderate to severe ischemic stroke (NIHSS: 9.9±2.51) and the majority were at risk of malnutrition according to NRS 2002 (92.3% vs. 93.8%, p=0.55). The majority of patients with acute ischemic stroke were moderately malnourished according to the NRI risk score (moderate risk, 52.4%), followed by mild malnutrition risk (23.8%). Patients had low levels of albumin (3.1±0.58 g/dL), prealbumin (13.0±5.40 mg/dL), and hemoglobin (11.6±2.34 g/dL). Total cholesterol (188.7±35.43), triglycerides (134.2±57.43 mg/dL), and LDL (118.7±31.42 mg/dL) were in the normal range, while HbA1c (6.8±2.40) and fasting plasma glucose (150.0±69.00 mg/dL) levels were high. Therefore, this study emphasizes the importance of assessing malnutrition and monitoring biochemical parameters.

Keywords: Acute ischemic stroke, biochemical parameters, malnutrition, nutritional status

Özet

Akut inme sonrası iskemik inme hastalarında bilinç bozukluğu, disfaji, yorgunluk ve algı bozukluklarından kaynaklanan beslenme sorunları ve beslenme yetersizlikleri sıklıkla görülebilmektedir. Disfajili hastalarda gelişen ağırlık kaybı sıklıkla malnütrisyona neden olabilmektedir. Bu çalışma, akut iskemik inme hastalarında inme şiddetini ve beslenme durumunu belirlemek ve malnütrisyon riskini saptamak amacıyla yapılmıştır. İskemik inme hastalarının beslenme durumu NRI ve NRS 2002 ile değerlendirilmiş ve bazı biyokimyasal parametreleri hasta dosyasından alınarak incelenmiştir. Tüm hastalarda orta ila şiddetli iskemik inme vardı (NIHSS: 9.9±2.51) ve NRS 2002'ye göre hastaların çoğunluğu malnütrisyon riski altındaydı (%92,3'e karşı %93,8, p=0,55). NRI risk skoruna göre hastaların büyük bir çoğunluğunun orta derecede malnütrisyonlu (%52,4) olduğu bunu hafif malnütrisyon riskinin (%23,8) takip ettiği görülmüştür. Hastaların albümin (3,1±0,58 g/dL), prealbumin (13,0±5,40 mg/dL) ve hemoglobin (11,6±2,34 g/dL) düzeyleri düşük bulunmuştur. Total kolesterol (188,7±35,43), trigliserid (134,2±57,43 mg/dL) ve LDL (118,7±31,42 mg/dL) seviyeleri normal sınırlarda bulunurken, HbA1c (6,8±2,40) ve açlık plazma glukozu (150,0±69,00 mg/dL) dL) yüksek bulunmuştur. Sonuç olarak, bu çalışma malnütrisyon değerlendirmesinin ve biyokimyasal parametrelerin izlenmesinin önemini vurgulamaktadır.

Anahtar Kelimeler: Beslenme durumu, biyokimyasal parametreler, akut iskemik inme, malnütrisyon

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Introduction

Stroke is the second most common cause of death after cardiovascular disease and causes permanent disability (Çubuk et al., 2020). Acute ischemic stroke, which is caused by atrial fibrillation and thromboembolism, is the most common type of stroke, accounting for 85.0% of cases (Patil et al., 2022). It has been reported that one in four people over the age of 25 are likely to suffer a stroke in their lifetime and around 5.5 million people will die as a result of stroke (GBD 2016 Stroke Collaborators). According to the projection for the elderly population, the prevalence of stroke will increase by 35.0% by 2050 and the burden of stroke is not expected to be reduced with the current prevention and intervention studies (Norrving et al. 2019). Stroke is the second leading cause of death in Turkey after cardiovascular disease and the first among diseases leading to permanent disability, with an incidence of 177/100,000 and a prevalence of 254/100,000 (Çubuk et al., 2020).

Nutritional problems and inadequacies caused by impaired consciousness, fatigue, dysphagia, postural, and perceptual disturbances can be common in stroke patients. Dysphagia is observed in 11.2-87.5% of patients with acute stroke and in 11-50% dysphagia persists until the sixth month (Krishnamurthy et al., 2022). Patients with dysphagia may experience weight loss due to nutritional deficiency, which exacerbates dysphagia and leads to malnutrition (Güçmen et al., 2022). Dysphagia is a risk factor for malnutrition and can lead to negative health outcomes by exacerbating malnutrition status (Güçmen et al., 2022; Liu et al., 2022) which is quite common in individuals with stroke (6.1–79.0%) (Arnold et al., 2016; Lu et al., 2023).

Nutrition is considered a modifiable risk factor in stroke prevention (Arnett et al., 2019; Pandian et al., 2018; Spence, 2019), and an important determinant of stroke prognosis (Irisawa et al., 2020; Sato et al., 2019; Sato et al., 2022). Hypercatabolism, hypermetabolism, and the acute stress response caused by acute stroke can trigger malnutrition. Metabolic stress and undesirable malnutrition can reduce protein synthesis and increase protein degradation. It can therefore worsen the prognosis of stroke (Burgos et al., 2018). In contrast, high protein intake after stroke may contribute to increased paretic limb motor activity and cortical plasticity and stimulate axonal sprouting via several mechanisms (Burgos et al., 2018; Steele et al., 2016). A diet with adequate energy, protein, fibre, vitamins and minerals may have a positive on stroke recovery and may also be associated with improved health outcomes such as life activities, motor/cognitive function, and mental health (Ko & Shin, 2022). There is an increasing awareness that malnutrition has a negative impact on survival rates and neurological recovery of stroke patients (Cai et al., 2020; Lu et al., 2023; Qin et al., 2021; Sato et al., 2021; Scrutinio et al., 2020; Yuan et al., 2021). Regardless of whether before or after acute stroke, malnutrition is responsible for poor functional outcomes, prolonged hospitalisation and increased mortality within 3-6 months after stroke (Ciancarelli et al., 2023; Sabbouh and Torbey, 2018). Recent data emphasize the importance of timely optimal nutritional intervention in stroke patients who are malnourished or at risk of malnutrition (Ko & Shin, 2022). Considering that malnutrition is a crucial factor for stroke prognosis given the existing literature data, this study was conducted to determine the severity of stroke and nutritional status in acute ischemic stroke patients and to investigate the risk of malnutrition.

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1. Method

This study was conducted on patients (n=42) who were diagnosed with acute ischemic stroke between January 2023 and March 2024 in the Stroke Service of Goztepe Prof. Dr. Suleyman Yalcin City Hospital Neurology Clinic.

2.1. Aim of Study

This study was conducted to determine the severity of stroke and nutritional status in patietns with acute ischemic stroke and to determine the risk of malnutrition.

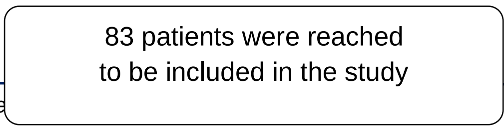
2.2. Research Questions

What is the prevalence of malnutrition in patietns with acute ischemic stroke?
What is the severity of stroke in acute ischemic stroke patients?
Is the nutritional status of acute ischemic stroke patients optimal?
Are the biochemical parameters of acute ischemic stroke patients optimal?

2.3. Population and Sample of the Research

As there was no comparable study, the sample size was determined using a one-tailed t-test analysis for independent samples with a margin of error of 5, a confidence level of 95% (1-α), a test power of (1-β), and an effect size of d = 0.93 based on the body mass index parameter of a study investigating the effect of enteral nutrition (Onodera et al., 2021), and based on the albumin parameter of another study (Mori and Yoshioka, 2020) (5% margin of error, 95% confidence (1-α), 95% test power (1-β), d=1.33 effect size). To keep the sample power higher, a total of 42 patients were included in the study, homogenized as much as possible and randomly included. Patients with primary or recurrent stroke aged between 18 and 80 years with a National Institute of Health Stroke Scale (NIHSS) score between 5 and 21, for whom nasogastric tube feeding was indicated and a hospital stay of at least 7 days was planned were included. Exclusion criteria were expected discharge before 7 days or ex, presence of edema/atrophy, pancreatic insufficiency (steatorrhea), history of cancer, organ dysfunction, renal/liver failure, contraindication to enteral feeding, NIHSS score below 5 and above 21, noncompliance with nasogastric tube feeding, presence of residuals, and failure to reach predicted target nutritional intake. The patient flow chart and intervention processes are shown in Figure 1. Patients or their accompanying people presenting to the stroke unit were informed about the study and their consent was obtained.

Figure 1. Patient workflow chart and intervention processes



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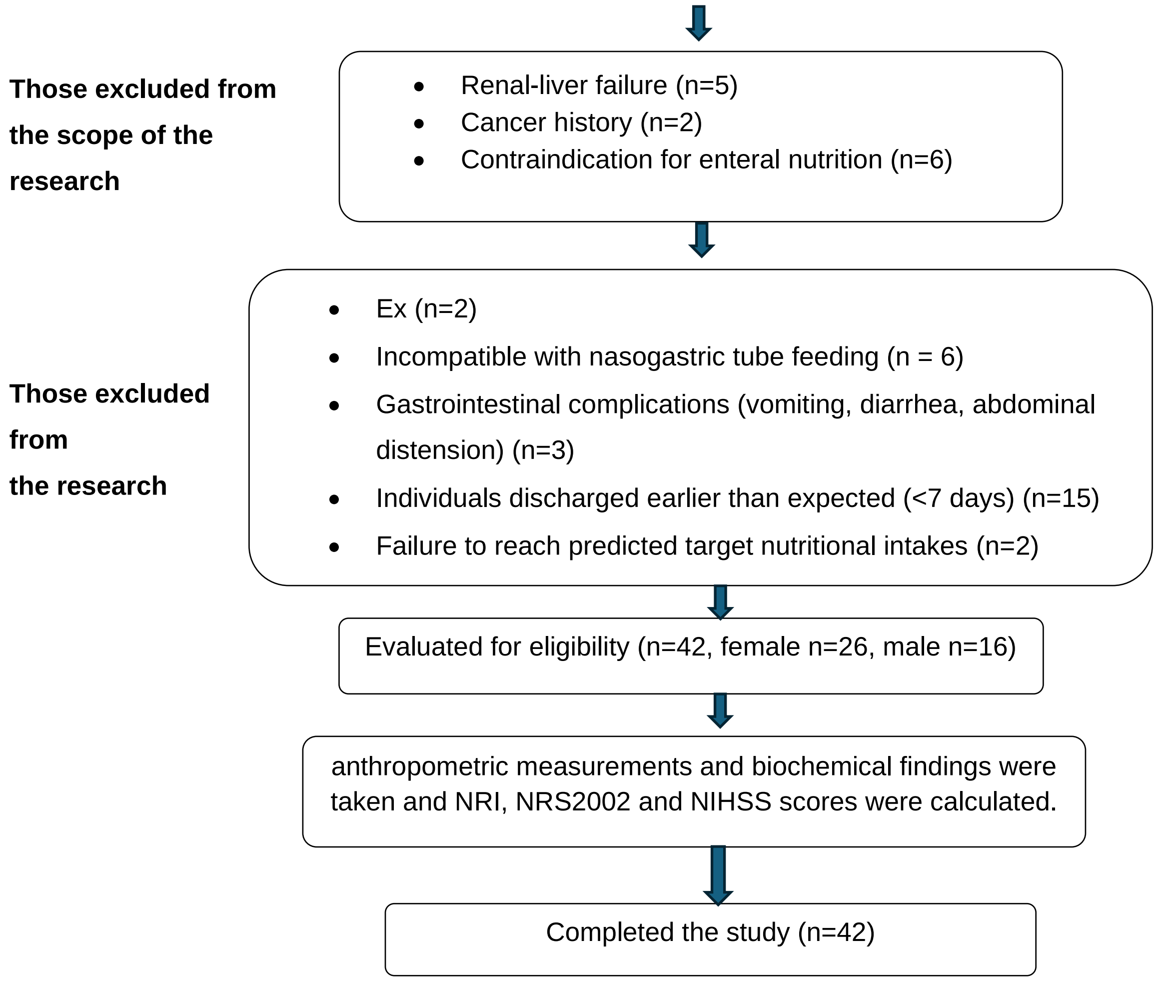

2.4. Data Collection and Measurements

The general characteristics of the patients (age, sex, etc.), medical history, severity of the stroke, clinical findings, biochemical parameters, and nutritional status before the nasogastric tube feeding intervention were analyzed in detail. The National Institutes of Health Stroke Scale (NIHSS) was used to determine stroke severity. Anthropometric measurements (body weight, triceps skinfold thickness, upper mid-arm circumference, calf circumference, etc.) were taken, and the Nutritional Risk Index (NRI) and Nutritional Risk Screening 2002 (NRS-2002) were used to assess the nutritional status of patients with ischaemic stroke.

2.4.1. Anthropometric measurements

The nutritional status of the stroke patients was assessed using anthropometric measurements such as body weight, calf circumference, mid-upper arm circumference and triceps skinfold thickness. The anthropometric measurements were taken by the researcher. While the anthropometric

measurements were taken directly in mobile patients, in non-mobile patients, knee height and upper mid-arm circumference were measured using a rigid tape measure and height and body weight were

calculated using equations (Pekcan, 2018). Height and body weight were calculated according to the following equation (Pekcan, 2018); *Height* "19-59-years-old male: (KH x 1.88) + 71.85
19-59-years-old female: (KH x 1.86; age x 0.05) + 70.25
60-80-years-old male: (KH x 2.08) + 59.01
60-80 years female: (KH x 1.91) - (age x 0.17) + 75.00"

Body weight
"19-59-years-old male: (KH x 1.19) + (UMAC x 3.21)-86.82
19-59-years-old female: (KH x 1.01) + (UMAC x 2.81)-66.04
60-80-years-old male: (KH x 1.10) + (UMAC x 3.07)-75.81
60-80 years old female: (KH x 1.09) + (UMAC x 2.68)-65.51
(KH: knee height, UMAC: upper-middle arm circumference)"

The BMI (kg/m^2) was calculated by dividing the weight (kilogrammes) by the height (metres) squared. The BMI classification ranges for older people have not yet been finalized, but these values were determined in a study conducted in our country. According to the results of this study, BMI as the "optimal BMI cutoff value for determining the desirable values of geriatric assessment parameters was found to be 31–32 and 27–28 kg/m^2 for women and men, respectively" (Kıskaç et al., 2022). The skinfold thickness of the triceps was measured twice with a skinfold caliper (Saehan, SH5020), midway between the olecranon and acromion in a vertical position with the left arm free at the side of the body, and the average was taken. The circumference of the upper mid-arm was measured twice with a non-flexible tape measure by bending the arm at the elbow 90° and marking the midpoint between the acromion at the shoulder and the olecranon at the elbow, and the average was taken (Pekcan, 2018). The muscle circumference of the upper middle arm and the muscle area of the upper middle arm were calculated using the equation that takes into account the circumference of the upper middle arm and the measurements of the skinfold thickness of the triceps (Pekcan, 2018).

"UMAMC (cm) = UMAC (cm) - [π x TST (cm)]
UMAMA (cm^2) = [(UMAC (cm) - π x TST (cm)) ^{2} / 4π] - 10 (Male)
UMAMA (cm^2) = [(UMAC (cm) - π x TST (cm)) ^{2} / 4π] - 6.5 (Female) (π = 3.1416)"

(UMAMC: upper-middle arm muscle circumference, UMAC: upper-middle arm circumference, TST: triceps skinfold thickness, UMAMA: upper middle arm muscle area)

Body fat percentage was calculated using an equation consisting of age and the triceps parameter (Lean et al., 1996).

"Body fat percentage for men = (1.31 x triceps) + (0.430 x age) - 9.16,

Body fat percentage for women = (0.944 x triceps) + (0.279 x age) + 4.6"

2.4.2. Assessment of Nutritional Status

The nutritional status of patients was determined using the NRI (Veterans Affairs Total Parenteral Nutrition Cooperative Study Group, 1991), which identifies patients at nutritional risk, and the NRS-2002, a screening tool recommended by ESPEN (Kondrup et al. 2003) to assess nutritional adequacy. A validity and reliability study in hospitalized patients was conducted by Bolayir et al. (Bolayir et al., 2019). There are two types of screening methods in NRS-2002: preliminary screening and baseline screening. Preliminary screening is continued or completed by answering yes or no to questions about changes in food intake, BMI and weight loss. If one of these questions is answered with "yes", the actual screening continues. If all questions are answered with "no", the patient is scanned again every week. The main screening consists of two parts: "Nutritional status" and "Severity of disease." Each section is scored between 0 and 3. For patients 70 years and older, 1 point is added to the score. Patients with a total score <3 are recommended to be examined every week. Patients with a total score of ≥3 are considered at nutritional risk. The NRI (=1.519 x albumin (g/l) + 41.7 x final body weight/continuous (average) body weight) is a simplified screening tool developed to assess nutritional status as a sensitive, specific marker for identifying patients at risk for postoperative complications based on clinical outcomes such as body weight and height and biochemical parameters such as albumin (Veterans Affairs Total Parenteral Nutrition Cooperative Study Group, 1991). Malnutrition, as defined by the NRI, has been reported to be associated with poor prognosis in patients with myocardial infarction, atrial fibrillation and heart failure (Ma et al., 2021). If the NRI score is above 100, there is no risk of malnutrition, and a score between 97.5 and 100 is defined as mild malnutrition. A score between 83.5 and 97.5 is defined as moderate malnutrition and a score below 83.5 is defined as severe malnutrition (Aziz et al. 2011).

2.4.3. Biochemical Parameters

After the patients were admitted to the clinic, the necessary biochemical analyses were performed. Serum lipid levels (total cholesterol (TC), low-density lipoprotein (LDL), triglyceride (TG), high-density lipoprotein (HDL)), hemogram values (hemoglobin, platelet, neutrophils, lymphocytes, etc.), thyroid gland values, blood glucose levels, etc.).), thyroid levels, fasting plasma glucose, HbA1C, serum proteins (albumin, prealbumin), troponin I, C-reactive protein, serum B12, folic acid, 25-hydroxyvitamin D3, sodium and potassium levels were examined. The systemic immune inflammatory index (SII), which is calculated from a blood count based on platelet, neutrophil and lymphocyte counts, has been shown to be a good marker in the diagnostic evaluation of stroke (Çakır et al., 2023). In this study, the SII (SII = P×N/L, P: platelets, N: neutrophils, L: lymphocytes) was used to evaluate the prognosis of ischemic stroke. A high SII value is associated with poor health (Hu et al., 2014).

2.4.4. Stroke Severity

The National Institute of Health Stroke Scale (NIHSS), which is used clinically to assess stroke prognosis, was used to assess the severity of stroke. It includes questions on state of consciousness, extraocular muscle movements, visual field, loss of sensory perception, response to commands, limb motor movements, limb ataxia, aphasia, dysarthria, and neurological neglect. 42 points is the highest score that can be achieved on the scale, and a higher score is associated with a higher risk of death.

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To define the risk of severe disability or high mortality, the NIHSS score should be 16 and above, and to define a good prognosis, the score should be below 6 (Sumer et al., 2015).

2.5. Ethical Considerations

The study protocol was approved by the Clinical Research Ethics Committee of Istanbul Medeniyet University Göztepe Training and Research Hospital Clinical Research Ethics Committee with decision number 2022/0723 and was conducted in accordance with the ethical principles of the Declaration of Helsinki. This study was carried out with the support of project ID number 11069 approved by the Scientific Research Projects Committee of Marmara University.

2.6. Limitations

As this study aimed to determine malnutrition and nutritional status, a limitation of this study is that it did not investigate the relationship between stroke outcomes and nutritional status. This study has several limitations such as limited sample size, limited biochemical parameters, limited evaluation period and inability to follow long-term outcome.

2.7. Data Analysis

The analyses were carried out using the SPSS 23.0 package programme. In descriptive statistics, categorical variables were presented as frequency and percentage, numerical variables were presented as mean and standard deviation if they were suitable for a normal distribution, and as median if they were not suitable for a normal distribution. For pairwise group analyses, chi-square and t-tests for independent groups were used to compare independent groups. The statistical significance level was set at $p<0.05$.

2. Results

The general characteristics of the stroke patients are listed in Table 1. All patients had moderate to severe ischemic stroke and the mean age was 69.6±8.69 years. Men and women were similar in terms of age, stroke severity, smoking, medical history, diseases and family history of stroke.

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Table 1. General characteristics of the acute ischemic stroke patients

Characteristics		*Total (n=42)*	*Female (n=26)*	*Male (n=16)*	*P-value*
Diseases ***n (%)***	Hypertension	28 (66.7)	17 (65.4)	11 (68.8)	
	Cardiovascular disease	8 (19.0)	6 (23.1)	2 (12.5)	
	Psychological illness	5 (11.9)	3 (11.5)	2 (12.5)	0.52
	None	1 (2.4)	-	1 (6.2)	
Smoking status	Yes *n (%)*	10 (23.8)	5 (19.2)	5 (31.2)	0,37
	No *n (%)*	32 (76.2)	21 (80.8)	11 (68.8)	
	Usage period (years Mean ± SD)	7.7 ± 13.50	5.5±12.02	11.2 ± 15.4	0,02
	Number of cigarettes (pieces/day, mean ± SD)	4,0 ± 7,34	3.0 ±6.79	5.6 ±8.13	0,13
Stroke type ***n (%)***	Ischemic stroke	42 (100.0)	26 (50.0)	16 (50.0)	
Stroke severity ***n (%)***	Moderate	42 (100.0)	26 (50.0)	16 (50.0)	
Recurrent stroke ***n (%)***	Yes	18 (42.9)	13 (50.0)	5 (31.2)	0.23
	No	24 (57.1)	13 (50.0)	11 (68.8)	
Family stroke history ***n (%)***	Yes	19 (45.2)	11 (42.3)	8 (50.0)	0.62
	No	23 (54.8)	15 (57.7)	8 (50.0)	
Age (years, *mean ± SD)*		69.6 ± 8.69	70.1 ± 8.16	68.8 ±9.71	0.11

Independent sample t test, Chi square test, Mean ± SD= Mean ± Standard Deviation

Information on the severity of stroke, malnutrition status and systemic immune inflammation status of the patients is shown in Table 2. There was no significant difference in stroke severity between genders; the NIHSS score was 10.0±2.65 for women and 9.8±2.36 for men (p=0.39). Patients in both groups were moderately malnourished and had similar NRI scores (93.9±10.03 vs. 94.6±7.96, p=0.81). When the risk of malnutrition was assessed using the NRS 2002, the majority were at risk of malnutrition (92.3% vs. 93.8%, p=0.55). Stroke severity, malnutrition status and systemic immune inflammation score did not differ between genders.

Table 2. Stroke severity and nutritional status of acute ischemic stroke patients

Stroke & Nutritional Status		*Total (n=42)*	*Female (n=26)*	*Male (n=16)*	*P*-value
NIHSS score *(Mean ± SD)*		9.9±2.51	10.0±2.65	9.8±2.36	0.39
NRS 2002 score *(Mean ± SD)*		4.1±0.76	4.1±0.73	4.1±0.83	0.59
NRI score *(Mean ± SD)*		94.2±9.20	93.9±10.03	94.6±7.96	0.81
Systemic immune inflammation score *(Mean ± SD)*		2225±2085.5	2544±2324.1	1707±1556.6	0.52
NRI score classification *(n%)*	No risk (>100 score)	6 (14.3)	4 (15.4)	2 (12.5)	0.82
	Mild risk (97.5–100 score)	10 (23.8)	6 (23.1)	4 (25.0)	
	Medium risk (83.5–97.5 score)	22 (52.4)	14 (53.8)	8 (50.0)	
	Major risk (<83.5 score)	4 (9.5)	2 (7.7)	2 (12.5)	
NRS 2002 score *(n%)*	No risk (<3 score)	3 (7.1)	2 (7.7)	1 (6.2)	0.55
	Malnutrition risk (≥3 score)	39 (92.9)	24 (92.3)	15 (93.8)	
BMI classification	Underweight or Malnutrition	28 (66.7)	16 (57.1)	12 (42.9)	0.10
	Normal	8 (19.0)	4 (50.0)	4 (50.0)	
	Overweight or Obese	6 (14.3)	6 (100.0)	-	

Independent sample t test, Chi square test, Mean ± SD= Mean ± Standard Deviation

Table 3 shows the body composition of the stroke patients. The average body weight of the patients participating in the study was 67.3±12.83 kg. The circumference of the upper middle arm was 29.6±4.49 cm and the calf circumference was 31.3±1.85 cm. Women had higher values of triceps skinfold thickness and body fat percentage, while men had higher values for muscle mass markers such as calf circumference, upper mid-arm muscle circumference, upper mid-arm circumference, and upper mid-arm muscle area.

Table 3. Body composition of the acute ischemic stroke patients

Body composition	*Total (n=42)* *(Mean ± SD)*	*Female (n=26)* *(Mean ± SD)*	*Male (n=16)* *(Mean ± SD)*	*P*-value
Body weight (kg)	67.3±12.83	64.1±14.03	72.6±8.63	0.02
Upper middle arm circumference (cm)	29.6±4.49	28.8±5.35	30.8±2.16	0.000
Calf circumference (cm)	31.3±1.85	30.8±2.07	32.3±0.89	0.007
Upper-middle arm muscle circumference (cm)	24.1±4.08	22.3±4.14	27.1±1.29	0.000
Upper middle arm muscle area (cm²)	48.8±16.63	40.6±15.42	62.1±7.39	0.005
Triceps skinfold thickness (mm)	16.9±8.95	19.9±8.92	12.0±6.74	0.009
Body fat (%)	25.0±4.18	26.5±2.57	22.6±5.20	0.001

Independent sample t test, Mean ± SD= Mean ± Standard Deviation

Table 4 shows the biochemical parameters of the stroke patients. The values of blood lipid parameters, including total cholesterol (188.7±35.43), triglycerides (134.2±57.43 mg/dL), and LDL (118.7±31.42 mg/dL) were within normal limits, while HbA1c (6.8±2.40) and fasting plasma glucose (150.0±69.00 mg/dL), which indicate glycemic status, were high. CRP levels (11.2±4.45 mg/L), an indicator of inflammation, and troponin 1 (ng/mL), an indicator of cardiac damage, were found to be high. In terms of nutritional status, patients had low levels of albumin (3.1±0.58 g/dL), prealbumin (13.0±5.40 mg/dL), and hemoglobin (11.6±2.34 g/dL).

Table 4. Biochemical parameters of the acute ischemic stroke patients

Biochemical parameters	***Total (n=42)*** *(Mean ± SD)*	***Female (n=26)*** *(Mean ± SD)*	***Male (n=16)*** *(Mean ± SD)*	***P*-value**
Glucose (mg/dL)	150.0±69.00	156.2±76.99	139.9±54.39	0.21
Low-density lipoprotein (mg/dL)	118.7±31.42	128.3±27.94	103.3±31.37	0.01
High-density lipoprotein (mg/dL)	44.9±11.55	46.5±11.00	42.3±12.30	0.91
Triglyceride (mg/dL)	134.2±57.43	140.6±62.45	123.9±48.27	0.23
Total cholesterol (mg/dL)	188.7±35.43	202.2±33.56	166.8±26.98	0.003
Thyroid stimulating hormone (mIU/L)	1.4±1.10	1.5±1.26	1.2±0.76	0.008
Triiodothyronine (pg/mL)	2.4±0.56	2.4±0.70	2.3±0.45	0.37
Thyroxine (ng/dL)	1.2±0.23	1.3±0.23	1.2±0.21	0.15
C-reaktif protein (mg/L)	11.2±4.45	11.3±4.58	11.2±4.20	0.23
Troponin (ng/mL)	0.04±0.05	0.04±0.05	0.03±0.04	0,53
Albumin (g/dL)	3.1±0.58	3.1±0.67	3.1±0.28	0.75
Prealbumin (mg/dL)	13.0±5.40	13.1±5.58	13.0±5.14	0.55
HbA1c (%)	6.8±2.40	7.0±2.68	6.5±1.89	0.21
Hemoglobin (g/dL)	11.6±2.34	11.8±2.57	11.3±2.10	0.41
Vitamin B12 (pg/mL)	448.9±407.34	433.1±348.69	474.6±499.75	0.38
Folic acid (ng/mL)	7.86±4.58	8.6±5.14	6.5±3.22	0.02
Vitamin D3 (ng/mL)	22.3±17.72	24.7±18.11	18.4±16.88	0.63
Sodium (mmol/L)	135.8±18.25	134.6±21.45	139.5±16.13	0.96
Potassium (mmol/L)	4.1±0.68	4.2±0,59	4.0±0.81	0.33

Independent sample t test, Mean ± SD= Mean ± Standard Deviation

3. Discussion

According to the ESPEN guideline, stroke patients should be assessed for malnutrition risk within the first 48 hours, and if malnutrition risk is present, stroke patients should receive optimal medical nutrition therapy as part of an individualised nutrition care (Burgos et al., 2018). It was found that the majority of stroke patients (66.7%) were at risk of malnutrition and could not be provided with adequate energy at the time of admission to hospital (Weun et al., 2019). It is known that up to 72% of stroke patients suffer from malnutrition (Huppertz et al., 2021). In a study assessing the risk of malnutrition with the MNA, it was found that 12.1% of all stroke patients were malnourished, 54.1% were at risk of malnutrition, and 59.5% of patients with moderate stroke severity were at risk of malnutrition (Hsieh et al., 2017). In a study examining malnutrition in stroke patients using the NRS 2002, the rate of those at risk of malnutrition was 46.5% (Liu et al., 2022). In a study conducted in

Turkey, the malnutrition status of stroke patients on admission was examined using the NRS-2002 and the MNA and it was found that 52% of the patients were malnourished and 66.1% of patients over 65 years of age were malnourished (Çoban, 2019). In a study examining the prevalence of malnutrition in stroke patients with dysphagia, the prevalence of malnutrition in acute and subacute stroke patients with dysphagia increased from 58.9% to 78.9% (Yoon et al., 2023). In this study, according to the NRI risk screening, the majority of the patients with acute ischemic stroke were found to be moderately malnourished (moderate risk, 52.4%), followed by mild risk (23.8%). According to the NRS 2002 screening, 92.9% of patients were found to be at risk for malnutrition. Clinical conditions such as the presence of comorbidities, stroke severity, age, polypharmacy, functional impairment in daily living activities, dysphagia or difficulty in feeding increased the risk of malnutrition. In particular, diabetes mellitus and recurrent stroke increase the risk of malnutrition by 58% and 71% respectively (Bouziana & Tziomalos, 2011; Gonh et al., 2021; Hsieh et al., 2017). In this study, the high malnutrition risk can be attributed to the patients' high glycemic parameters, history of stroke, and dysphagia. There are different types of screening tools for malnutrition in stroke patients, and the results variable (Lu et al., 2023). There is no gold standard method for the assessment of nutrition in stroke patients (Foley et al., 2009; Liu et al.,2023; Lu et al., 2023). Due to the use of different screening tools in the studies, the lack of superiority of each screening tool over the others, and the methodological and sampling differences between the studies, it is not possible to draw a clear conclusion regarding the risk of malnutrition. As nutritional status assessment is known to consistently predict physical function outcomes in stroke patients (Liu et al., 2023), early identification of patients at risk of malnutrition may lead to a significant improvement in stroke prognosis by enabling the development of optimal nutritional strategies for better clinical outcomes (Khoshbonyani et al., 2020; Lu et al., 2023).

Nutritional status is assessed by various biomarkers such as serum albumin and prealbumin (Kim et al., 2023). Albumin is used as an indicator of malnutrition and a significant decrease in muscle mass may be associated with low albumin levels. (Kim et al., 2023). As a result of systemic inflammation, albumin production is suppressed, albumin degradation and transcapillary leakage are increased. (Kim et al., 2023). Prealbumin is a transport protein for thyroid hormones that is produced by the liver. A serum prealbumin levels of less than 10 mg/dL is associated with malnutrition (Kim et al., 2023). Prealbumin is a better marker than albumin, as it has a shorter half-life (2-3 days) and better reflects sudden changes in malnutrition (Kim et al., 2023). Serum prealbumin is an important biomarker that can predict ischemic stroke-induced infection. Decreased serum prealbumin level, which has been shown to be a biomarker for malnutrition and central nervous system damage-induced immunosuppression syndrome, may be a useful biomarker for stratifying the risk of stroke-related infection in the acute phase. A prealbumin level≤19.1mg/dL can be used as a biomarker for risk assessment of stroke-related infections in the acute phase of ischemic stroke (Ye et al., 2017). A serum albumin level of ≤3.5 g/dL and a prealbumin level of ≤20 mg/dL are considered low prealbumin levels (Kim et al., 2023). Tube-fed patients with neurological dysphagia have been reported to have normal body weight but low serum albumin levels (Obara et al., 2008). In a study examining biochemical parameters, albumin and prealbumin levels of 2.9±0.4 g/dL and 16.5±3.9 mg/dL, respectively, were found in elderly stroke patients on admission to hospital (Obara et al., 2010). In another study (n=180), a mean serum albumin level of 2.97 ± 0.58 mg/dL and a serum albumin level of .59 ± 3.77 mg/dL were found in ischemic stroke patients (Kim et al., 2023). In a nutritional intervention study (n=36), a serum albumin level of about 3.77 g/dL and a prealbumin level of 16 mg/dL were found in the intervention group (Wuryanti et al., 2005). In a study examining blood parameters, albumin levels in acute stroke patients with poor and good clinical outcome were 3.84 ± 0.70 and 4.0 ± 0.29 g/L, respectively (Geng et al., 2016). In this study, an albumin level of 3.1±0.58 g/dL and a prealbumin level of 13.1±5.40 mg/dL were found in patients with acute stroke. Most studies that have focused on albumin and prealbumin levels in patients with acute ischemic stroke. The catabolic state that develops after an acute stroke and the resulting neuroendocrine response can lead to changes in serum albumin concentrations in the immediate post-stroke period. A high stress response in the first week after stroke is also associated with malnutrition (Wuryanti et al., 2005). Since albumin is a haemodilator agent that increases cerebral blood flow by reducing blood viscosity or by vasodilation in response to reduced oxygen delivery (Nayak et al., 2011), low albumin concentrations may predict unfavourable outcomes such as higher mortality rate and worsen the functional process in stroke patients (Babu, 2013; Gong, 2021; Kasundra, 2014).

It is generally accepted that serum lipid levels can be considered prognostic markers in patients with acute ischemic stroke (Deng et al., 2019). One study found that lower TG levels predicted in-hospital mortality and that severe stroke was associated with lower TG and HDL-C levels, while stroke severity was not associated with LDL levels. (Tziomalos et al., 2017). Although hyperlipidemia is known to be a risk factor for adverse cardiovascular disease outcomes, the results of many studies looking at the prognostic significance of serum lipids in acute ischemic stroke remain controversial (Deng et al., 2019). In this study, blood lipid levels such as total cholesterol (188,7±35,43 vs 184.0±41.0 mg/dL), trigliseride (134,2±57,43 mg/dL vs 148±77.0 mg/dL) LDL (118,7±31,42 mg/dL vs 127.0±92.0 mg/dL), and plasma glycaemic parameters such as fasting plasma glucose level (150.0±69.00 mg/dL vs 158.0±81 mg/dL) are similar to the study by Tamam et al. (2005). In another study, the mean blood glucose level was around 117.1 mg/dL, total cholesterol level 181.4 mg/dL, LDL level 116.0 mg/dL, HDL level 43.3mg/dL and triglyceride level 139.1 mg/dL (Geng et al., 2016). Ryu et al. found that the blood glucose level of patients with acute ischemic stroke and early neurological deterioration was 137.4 mg/dL, the LDL level was 114.1mg/dL, the triglyceride level was 140.8mg/dL, and the total cholesterol level was 175.2mg/dL (Ryu et al., 2016). The results of this study are consistent with the literature. It is known that acute ischemic stroke is characterised by high LDL, triglyceride and total cholesterol levels and low HDL levels, and it is believed that positive changes in lipid parameters may reduce the negative consequences of stroke (Huang et al., 2021; Perovic et al., 2016).

It has been suggested that inflammation plays an important role in the pathogenesis of acute ischemic stroke, and CRP, the classic acute phase reactant protein, is considered an inflammatory biomarker in cardiovascular disease and ischemic stroke (Geng et al., 2016). It is hypothesized that elevated CRP levels are an indicator of plaque instability and severity of atherosclerotic vascular disease and may play a direct role in the pathogenesis of plaque instability and atherosclerosis (Şengül et al., 2008). In the first 24 hours after a stroke, an increase in CRP concentration is observed, which is associated

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with infarct size and poor prognosis (Singh & Pradhan, 2021). Approximately 75% of patients with ischemic stroke have elevated serum levels of C-reactive protein (CRP), indicating a systemic inflammatory response, the extent of tissue damage, or concurrent infections (López & Dávalos, 2011). After excluding potential confounders, a CRP level ≥7 mg/L was significantly associated with an increased risk of poor stroke outcome (adjusted OR 1.6, 95% CI) or death (adjusted OR 1.7, 95% CI) at 3 months (den Hertog et al., 2009). Zhao et al. (2006) reported that stroke severity increased when abnormal CRP serum levels were reached and that the incidence of zonal infarcts was significantly higher than that of non-zonal infarcts. It is suggested that increased levels of inflammatory markers may indicate the severity of lesions in perforating arteries (Nakase et al., 2008). One study found that the average CRP level in patients with acute ischemic stroke was 8.5±12.65 mg/dL, and that of patients with poor prognosis was 18.8±19.05 mg/dL (Geng et al., 2016). In two studies in which patients with acute acute ischemic stroke (n=40), the mean CRP value was 7.95±3.81 mg/dL (Şengül et al., 2008) and 9.2±16.6 mg/dL (Koca & Arslan, 2019). In this study, a CRP level of 11.2±4.45 mg/dL was found. The differences in CRP levels between the studies may be attributed to factors such as sample characteristics, sample size, malnutrition and severity of stroke.

4. Conclusion

This study concluded that patients with acute ischemic stroke were moderately malnourished or mildly malnourished, with low blood protein levels, high glucose and CRP levels, and normal lipid levels. There are few studies investigating the nutritional assessment and stroke prognosis, especially the effect of post-stroke biochemical indicators and malnutrition status. This study highlights the importance of malnutrition assessment and monitoring biochemical parameters. As it is known that assessment of nutritional status consistently predicts physical performance in stroke patients, early identification of patients at risk of malnutrition may lead to a significant improvement in stroke prognosis by enabling clinicians to implement optimal nutritional management to achieve better clinical outcomes.

Yazarların Katkısı/Authors Contributions

Topic selection: YEB, BAÖ; Design: YEB, BAÖ, HHK; Planning: YEB, BAÖ; Data collection and analysis: YEB, HHK; Article writing: YEB; Critical review: BAÖ, HHK.

Çıkar Çatışması / Conflict of Interest

The authors declared no conflict of interest.

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