Is the Bioimpedance Method Sufficient in Evaluating the Nutritional Status of Patients Receiving Hemodialysis Treatment?*

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Abstract

Aim: The purpose of this study was to test validity of bioelectrical impedance (BIA) analysis in the nutritional assessment among patients with receiving hemodialysis.

Method: This study which was cross-sectional was conducted with 166 patients with hemodialysis at the hemodialysis units in two state hospital and a private hospital. The data were collected by means of patient information form, Malnutrition Inflammation Score (MIS) and Body Composition Analyzer. Descriptive, t test, Mann-Whitney U, chi-square, Wilcoxon, ROC analysis and logistic regresyon analysis were used in statistical analysis.

Results: The average ages of patients were 51.57±13.01 (21-66) years. Of the patients, 53.6% were male. Mean body mass index (BMI) was 24.4±4.98 kg/m² of whom (%54.8) were well-nourished. Male patients had higher albumin, muscule mass, and BMI than female patients and these values were statistical difference in according to gender. A significant difference was found to hemoglobin, albümin, iron binding, tanita fat ratio, fat mass, and BMI between the well-nourished and malnourished patients. The findings of logistic regretion analysis among MIS and BIA parameters shown that performance of BIA was statistical significantly.

Conclusion: The results of study indicated that bioelectrical impedance analysis was shown to identify the most suitable BIA parameters for predicting presence of malnutrition. It could be suggested that BIA method may use for assess to nutritional status among patients receiving hemodialysis.

Keywords: Nutritional status, malnutrition, nutrition assessment.

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ETHICAL STATEMENT: Ethics committee approval was received for this study from the ethics committee of Manisa Celal Bayar University Faculty of Medicine (Ethics number: 23/05/2018/20.76.485).

Hemodiyaliz Tedavisi Alan Hastaların Beslenme Durumlarının Değerlendirilmesinde Biyoempedans Yöntemi Yeterli Midir?

Öz

Amaç: Bu çalışmada amaç, biyoempedans analiz (BIA) yönteminin hemodiyaliz tedavisi alan hastaların beslenme durumlarının değerlendirilmesinde güvenilirliğinin test edilmesidir.

Yöntem: Kesitsel tipteki bu çalışma, iki devlet hastanesi ve bir özel hemodiyaliz merkezinde hemodiyaliz tedavisi alan 166 hasta ile yürütüldü. Araştırmada veriler, hasta tanıtım formu, Malnutrisyon Inflamasyon Skoru (MIS) ve biyoempedans temeline dayalı Çoklu Vucüt Analiz Cihazı ile toplandı. Verilerin değerlendirilmesinde tanımlayıcı istatistiksel analizler, t testi, Mann-Whitney U, ki kare, Wilcoxon, ROC analizi ve ikili logistik regresyon analizleri yapıldı.

Bulgular: Araştırmaya katılan hastaların yaş ortalaması 51,57±13,01 (21-66) yıl olup büyük çoğunluğu (%53,6) erkek idi. Hastalarının beden kütle indeksi (BKI) ortalaması 24,4 kg/m2 olup %54,8'nin beslenme durumunun iyi olduğu belirlendi. Erkek hastaların albümin, kas kütlesi ve BKI'leri kadın hastalardan daha yüksek bulundu. Beslenme durumu iyi olan hastalar ile malnutre olan hastalar arasında hemoglobin, albümin, demir bağlama, tanita yağ yüzdesi, tanita yağ kütlesi, tanita kas kütlesi ve beden kütle indeksi ölçümleri açısından istatistiksel olarak anlamlı fark olduğu belirlendi ($p<0,05$).

Sonuç: MIS değerleri ile BIA ölçüm parametreleri arasında yapılan logistik regresyon analizi sonucunda tanı testi performansı istatistiksel olarak anlamlı bulundu. Araştırma sonuçları BİA parametrelerinin malnutrisyonu öngörmede tanısal karar verdirici olduğunu gösterdi. Buna göre; BIA yönteminin hemodiyaliz tedavisi alan hastalarda beslenme durumlarının değerlendirilmesinde kullanılması önerilebilir.

Anahtar Sözcükler: Beslenme durumu, malnutrisyon, beslenme değerlendirmesi.

Introduction

The most frequently preferred renal replacement method in patients with chronic kidney disease (CKD) is defined as hemodialysis (HD). The aim of HD treatment is to correct the patient's fluid-electrolyte balance, prevent metabolic and extrarenal complications that may occur due to uremia, and prolong the patient's lifespan[1,2]. Nutrition is defined as an important factor in ensuring bone mineral metabolism disorders, blood pressure, and fluid-electrolyte balance in patients receiving hemodialysis treatment, preventing complications that may occur due to the disease and hemodialysis treatment, and improving the patient's quality of life. The aim of medical nutrition therapy in patients receiving HD treatment is to correct anemia, reduce inflammation, prevent the development of cardiovascular diseases, reduce symptoms such as nausea, vomiting, itching, and pain, and prevent malnutrition[3]. Protein-energy malnutrition (PEM), which is an important risk factor in terms of mortality and morbidity, begins in the early stages of chronic renal failure. It is reported in the literature that the incidence of malnutrition in patients receiving HD treatment is between 18 and 75%[4-7]. In patients receiving HD treatment, PEM increases the duration of hospital stay, development of complications, morbidity, and mortality, and reduces the quality of life[8-10]. Monitoring the nutritional status of patients receiving hemodialysis treatment also helps prevent malnutrition, alleviate uremia symptoms, ensure fluid and electrolyte balance, and reduce the risk of atherosclerosis[11,12]. In addition, it is emphasized that the evaluation of nutritional status in patients with end-stage renal failure (ESRD) is important in terms of mortality and morbidity[13]. While it has been stated that severe malnutrition increases the risk of cardiovascular death by 33% in patients receiving hemodialysis treatment[1-14], it has been stated that increasing body mass index (BMI) increases survival in patients receiving HD treatment, unlike healthy individuals[15]. It is possible to provide a quality life to patients receiving HD treatment with adequate dialysis dose, an effective vascular access route, prevention of infection, psychosocial support, and good nutrition[16,17]. Regular evaluation of the nutritional status of patients will enable malnutrition that may develop to be detected at an early stage and necessary interventions to be made. Maintaining and maintaining basic nutritional status is part of nursing care. The nurse should identify risks that will negatively affect the nutritional status and take preventive practices[18].

Many methods are recommended to evaluate the nutritional status of patients receiving hemodialysis treatment. Serum albumin level, creatinine, total cholesterol, and ferritin values in the evaluation of the nutritional status of the American National Kidney Foundation (NKF); dry weight determination, diet discussions, normalized protein nitrogen level; recommends the use of body composition analysis methods[19]. It is stated that serum protein levels, albumin, transferrin, and prealbumin (Transthyretin) should be used together with other parameters in the evaluation of nutritional status[20,21]. Bioelectrical impedance analysis (BIA) method is a frequently used method due to its ease of application, low cost, detailed and rapid data acquisition, and its usefulness in evaluating nutritional status and hydration[21-24].

There are no studies in the literature that evaluate the relationship between the BIA method and the Malnutrition Inflammation Score (MIS) in the evaluation of the nutrition of patients receiving HD treatment. In addition, the BIA method is recommended to be used by dialysis nurses as it is a fast and easy method for evaluating dry weight, fluid volume, and nutrition[25,26]. This study aims to test the reliability of the bioimpedance analysis method in evaluating the nutritional status of patients receiving hemodialysis treatment.

Material and Methods

Study Design and Participants

This descriptive and cross-sectional study included patients with hemodialysis who recruited from three dialysis centers situated in Manisa, Turkey, between September 2018 and January 2020. During the study, about 420 patients undergoing chronic hemodialysis presented to three dialysis centers. Of these, through simple random sampling, 166 patients who agreed to participate were included in this study. The patients were selected according to the following criteria; that had been on hemodialysis for one and over years, HBV, HCV, HIV negative, and non-malignancy, without lower limb amputation, between 18 and 65 years of age, not using nutritional products, able to speak and read Turkish, to be willing participant. The study purpose, procedural details, the participant's rights and potential benefits and risks of the study were explained and written consent forms were obtained from them.

Data Collection: Research data were collected by socio-demographic form, MIS, BIA, anthropometric measurement (caliper) method.

Socio-Demographic Form: The socio-demographic form elicited personal information such as age, gender, marital status, and education status, and medical history, serum biochemical parameters.

The Malnutrition-Inflammation Score: The MIS has four sections (nutritional history, physical examination, Body Mass Index (BMI), and laboratory values) and 10 components. Each component has four levels of severity, from 0 (normal) to 3 (severely abnormal). The sum of all 10 MIS components can range from 0 (normal) to 30 (severely malnourished); a higher score reflects a more severe degree of malnutrition and inflammation[27,28]. The MIS was recommended to use assessment of nutrition in patients of HD among Turkish population[29,30].

Tanita SC 330S Portable Body Composition Analyzer: Evalution of body composition Bioelectrical Impedance Analysis it was done by the method (BIA). Impedance obtained by multi-frequency BIA method by substituting the value into the fixed equations, the body fat percentage becomes amount, far free mass, body water percentage, body water amount, muscle, body components such as mass, bone mass, muscle ratio and BMI were calculated.

Holtein Skinfold Caliper

Based on skinfold thickness, which is an anthropometric measurement method. It is a tool that allows body analysis as a result of scientific studies. Measurements were made on the arm without arteriovenous fistula (AVF) while standing or sitting, depending on the patient's condition. With the thumb and index finger of the left hand where the measurement is made, while the subcutaneous fat thickness was kept, the tissue was held at a depth of approximately 1 cm with the caliper in the right hand. Measurements are from one side. It was done twice, 15 seconds apart. When there is more than 5% difference between two measurements Measurement was made for the 3rd time. Measurements were averaged.

A socio-demographic form, MIS and BIA were used the data gathering in face-to-face interviews. Nutritional status of patients were assessed concurrently with BIA, MIS, laboratory determinations, and anthropometric indexes. Anthropometric measurements, and laboratory measurements were performed on the same day as the MIS and BIA evaluation. After the hemodialysis session, sociodemographic form and the MIS were filled by the first researcher. Each patient was classified as MIS normal nutritional status, or malnutrition. Routine laboratory determinations (albumin, hemoglobin, hematocrit, glucose, URR, Kt/V, pre-dialysis blood urea nitrogen, post-dialysis blood urea nitrogen, pre-dialysis creatine, post-dialysis creatine, pre-dialysis potassium, post-dialysis potassium, calcium, phosphorus, iron binding capacity, interdialytic fluid intake) were obtained from folder of patients. The body weight (kg) and height (cm) were measured where the patients standing. Body mass index (BMI) was calculated as the ratio between end-dialysis body weight and the square of height. Also, blood pressure (mmHg) was measured where the patients sitting. Anthropometric measurements were obtained at the end of the dialysis treatment. Biceps skinfold (BSF) and triceps skinfold (TSF) thicknesses were measured with a Holtain Skinfold Kaliper. Bioimpedance indexes were measured with a bioimpedance instrument (Tanita-Body Composition Analyzer DC-360). Measurements were performed in the standing position with 4-electrodes connected to feets of patient’s. We obtained data of body fluid status and body composition parameters (fat free mass, fat mass, muscle mass, body weight) with the BIA parameters.

Statistical Analysis

Descriptive statistical analysis, t test, Mann-Whitney U, chi-square, Wilcoxon, ROC analysis and binary logistic regression analysis were used to evaluate the data. By evaluating Tanita measurements (fat percentage, fat mass, muscle mass, body mass index) together, MIS classification (good nutrition - bad nutrition) dependent variable is taken first for the performance of the diagnostic test for nutritional status and dual logistic regression analysis is performed for four independent variables. and the probability formula was given. The significance and explanatory power of the variables in the model were analyzed with the wald statistic, Cox & Snell R square and Nagelkerle R square values. With the diagnostic test combination method, the probabilities obtained from the logistic regression analysis obtained with four independent variables and the ROC (Receiver Operating Characteristic) analysis were performed and the AUC (Area Under Curve) values and significance were examined; shown in the table along with the confidence interval. In line with the information obtained here, the cut-off point was calculated according to the Youden index, and the cut-off point was reclassified and the sensitivity, selectivity, positive predictor (PPV) and negative predictor (NPV) as percentage (%) and confidence intervals (CI) in the table. was shown. In the analyzes, Type I error probability was determined as 0.05. Analyzes were performed using IBM SPSS V22 program[31-33].

Ethical Considerations

The study was conducted after obtaining approval from the Research Ethics Committee of Manisa Celal Bayar University, Manisa, Turkey (Ref. no.: 23/05/2018/20.76.485). Participants were informed about the study’s purpose, procedural details, their right and potential benefits and risks of the study. All participants were only included after they provided written consent forms.

Results

The average age of the patients who took hemodialysis treatment participating in the study was 51.57±13.01 (21-66) years, and the majority of them were male patients (53.6%). Descriptive characteristics of the patients who received hemodialysis treatment are shown in Table 1.

Table 1. Descriptive characteristics of patients receiving hemodialysis treatment (n=166)

Features	Number	%
Gender		
Female	77	46.4
Male	89	53.6
Marital status		
Married	135	81.3
Single	31	18.7
Education Status		
Literate	29	17.5
Primary school	102	61.4
Middle School	24	14.5
High school	9	5.4
University	2	1.2
Working Status		
Working	5	3
Not Working	161	97
Social security		
Yes	79	47.6
No	87	52.4
Causes of chronic kidney failure		
Diabetes	63	38
Hypertension	40	24.1
Chronic glomerulonephritis	11	6.6
Chronic Pyenonephritis	4	2.4
Other urological diseases	13	7.8
Other	35	21.1

Other: oncological diseases, genetic diseases

The CKD etiologies of the patients participating in the study were determined to be 38% diabetes, 24.1% hypertension, and 6.6% chronic glomerulonephritis, respectively. 3% of patients receiving HD treatment stated that they missed their hemodialysis sessions (Table 1). The laboratory findings of the patients are shown in Table 2.

Table 2. Laboratory findings of patients receiving hemodialysis treatment (n=166)

Parameters	Mean±Sd	Min-Max
Blood Glucose (mmol / L)	98±52.21	66 – 278
Hemoglobin (g / dl)	10.9±2.53	7.4 – 13.7
HTC (%)	32.83 ± 5.386	12.10-45
KTV	1.6±0.317	0.9 – 2.5
URR (%)	73.6±6.70	55– 88
Albumin (g / dL)	3.96±0.32	3.1 – 4.7
Sodium (mEq / L)	139±2.96	129 – 145
Phosphorus (mg / dL)	5±1.96	1.7 – 12.2
Calcium (mg / dL)	8.7±1.01	5 – 10.3
Iron Binding Capacity (ug/ dL)	199±45.20	109-369

Sd =Standard deviation; Min-Max = Minimum-Maximum

The average blood glucose of the patients is 98 mmol/L, the average hemoglobin level is 10.9 g/dl, the average hematocrit value (%) is 32.83±5.386, the average KT/V is 1.6. The mean URR (%) of the patients is 73.6, the mean value of albumin is 3.96 g/dl, the mean value of sodium is 139 mEq/dL, the mean phosphorus value is 5 mg/dL, the mean value of calcium is 8.7 mg/dl. The mean value of calcium is 8.7mEq/dL, the mean value of ıron binding capacity is 199 ug/dL (Table 2).

HD related values parameters of the patients receiving hemodialysis treatment are shown in Table 3.

Table 3. Hemodialysis-Related Values of Patients Receiving Hemodialysis Treatment (n=166)

Parameters	Mean±Sd#	Min-Max##
Pre-dialysis Urea (mg / dL)	113±33.50	50.2 – 205
Post Dialysis Urea (mg / dl)	29.6±10.5	12.2 – 60
Pre-dialysis Creatine (mg / dl)	6.8±2.66	1.7 – 14.5
Post Dialysis Creatine (mg / dl)	2.2±1.11	0.7 – 6.1

Pre-dialysis potassium (mEq ± / L)	5.4±0.63	3.6 – 7.3
Post-dialysis potassium (mEq / L)	3.7±0.31	2.8 – 4.6
Pre-Dialysis Systolic Blood Pressure (mmHg)	110±24.1	1 – 170
Systolic Blood Pressure After Dialysis (mmHg)	100±12.81	80 – 150
Pre-Dialysis Diastolic Blood Pressure (mmHg)	70±13.5	60 – 120
Post-Dialysis Diastolic Blood Pressure (mmHg)	70±8.24	60 – 80
Interdialytic Fluid Intake (kg)	3±1.06	1.1 – 7

Sd =Standard deviation; Min-Max = Minimum-Maximum

The mean urea value of the patients before/after hemodialysis is 113/29.6 mg / dl, the mean value of creatine before/after hemodialysis is 6.8/2.2 mg / dL, and the mean value of potassium before/after hemodialysis is 5.4/3.7 mEq / dL. The average systolic blood pressure of the patients before/after the hemodialysis session was 110/100 mmHg, while the average diastolic blood pressure before/after the hemodialysis session was 70 mmHg. The average interdialytic fluid intake of patients receiving hemodialysis treatment was found to be three kg. (Table 3).

Table 4. Body composition measurement parameters of patients receiving hemodialysis treatment (n = 166) (Continued)

Parameters	**Mean±Sd**	**Min-Max**
MIS	5±3.05	1 – 14
Tanita Fat Percentage	24.5±10.72	3 – 52.6
Tanita Fat Mass	15.1±9.46	1.2 – 54.5
Tanita muscle mass	44.6±8.79	27.8 – 66.9
Body Mass Index	24.4±4.98	14.2 – 43.1

Note: Sd =Standard deviation; Min-Max = Minimum-Maximum

The average MIS value of the patients participating in the study is 5. According to the MIS classification, 54.8% of the patients had good nutritional status, 29.5% were at risk of malnutrition, and 15.7% were malnourished. Among the body composition measurement parameters of the patients, the fat percentage was 24.5, fat mass was 15.1, muscle mass was 44.6 and BMI as 24.4 kg / m^2 (Table 4).

Table 5. Laboratory values and body composition measurement parameters by gender

Parameters	**Female (n=77)**		**Male (n=89)**		**p**
	Mean±Sd#		**Mean±Sd#**		
HTC (%)	33.07±4.138		32.63±6.286		0.603[a]
	Median	**Min-Max##**	**Median**	**Min-Max##**	
Tanita Fat Percentage	29.4	3 – 52.6	23.3	3 – 40.8	**<0.001[b]**
Tanita Fat Mass	17	1.3 –54.5	13.5	1.2 –30.8	0.197[b]
Tanita Muscle mass	39.1	27.8 – 61.1	49.7	32.2 –66.9	**<0.001[b]**
BMI	22.6	16.3 – 43.1	24.7	14.2 –34.5	0.845[b]
Hemoglobin (g/dL)	10.6	7.4 – 13.3	11	7.4 – 37	0.328[b]
Albumin (g/dL)	4	3.1 – 4.5	4	3.4 – 4.7	**0.027[b]**
Reinforcement Capacity (ug / dL)	193	109 – 301	202	114 – 369	0.200[b]

a: Student t test; Median ± Standard deviation b: Mann-Whitney U testi; Median (Minimum-Maximum)

A statistically significant difference was found between male and female patients in terms of Tanita fat percentage, Tanita muscle mass, albumin, and MIS classification (p<0.001, p<0.001, p=0.027, p=0.001) (Table 5).

Table 6. Evaluation of malnutrition inflammation score

MIS classification	**Female (n=77)**		**Male (n=89)**		**p**
	Number (n)	**Percent (%)**	**Number(n)**	**Percent (%)**	
Nutritional status good	23	29.9	50	56.2	**0.001[c]**
Malnutre	54	70.1	39	43.8	

c: Pearson Ki-kare testi; n(%)

According to the Malnutrition Inflammation Score, the nutritional status of female patients was found to be worse than that of male patients (Table 6).

Table 7. Evaluation of laboratory values and body composition measurements according to malnutrition inflammation classification

Parameters (n=166)	**Nutritional Status Good (n=73)**		**Malnutre (n=93)**		**p[a]**
	Median	**Min- Max**	**Median**	**Min- Max**	
Hemoglobin (g/dl)	11	8.3 – 37	10.8	7.4 – 13.3	**0.048**[*]
Albumin (g/dl)	4.1	3.4 – 4.7	4	3.1 – 4.5	**0.009**[**]
Iron Binding Capacity (ug / dL)	222	121 – 369	184	109 – 301	**<0.001*** **
Hemotocrit (%)	33.1	12.1 – 45	31.8	23.3-41.6	0.726
Ktv	1.6	1.2 – 2.2	1.6	0.9 – 2.5	0.921
URR	73	0.7 – 84	74	55 – 88	0.898
Urea before dialysis	112	62 – 205	112	50.2– 184	0.693
Urea after dialysis	25	14 – 60	29	12.2 – 56	0.632
Tanita Fat Percentage	29	12.8–52.6	20.5	3 – 50.4	**<0.001*** **
Tanita Fat Mass	19.7	8.5 – 54.5	13.3	1.2 – 43	**<0.001*** **
Tanita Muscle mass	52.2	33.9–61.1	40	27.8–66.9	**<0.001*** **
BMI	26.2	20.8–43.1	21.3	14.2-33.4	**<0.001**[***]

a: Mann-Whitney U test; Median (Minimum-Maximum) Note: * p <0.05, ** p <0.01, *** p <0.001

Between patients with good nutritional status and patients with malnutrition, a statistically significant difference was found in terms of hemoglobin (p=0.048), albumin (p=0.009), iron-binding (p<0.001), Tanita fat percentage (p<0.001), Tanita fat mass (p<0.001), Tanita muscle mass (p<0.001) and BMI (p<0.001) measurements (Table 7).

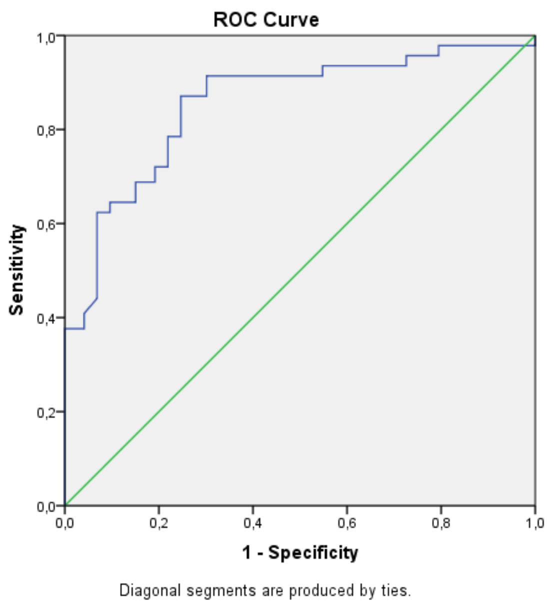
Table 8. Statistics of the model obtained by logistic regression analysis

	B	SE	p	Exp (b)	% 95 CI Exp (b)	
					Lower Limit	Upper Limit
Fixed (b0)	17.435	3.842	**<0.001**			
BMI (X1)	-0.281	0.114	**0.014**	0.755	0.604	0.944
Tanita Fat Percentage (X2)	-0.260	0.110	**0.019**	0.771	0.621	0.957
Tanita Fat Mass (X3)	0.283	0.125	**0.023**	10.328	10.039	10.696
Tanita Muscle Mass (X4)	-0.187	0.054	**0.001**	0.830	0.746	0.923

Logistic Regression Analysis; B:Coefficient,SE:Standart Eror, CI:Confidence Interval %95 C.I for Exp (b)

To determine whether Tanita Measurements (fat percentage, fat mass, muscle mass, and BMI) are an evaluation method for diagnosing nutrition in patients receiving hemodialysis treatment and to determine which limit values can predict this situation, the patients were divided into two groups as good and poor nutrition according to the MIS classification. Then, the logistic model was established with Tanita measurements. The probabilities obtained from the model established with four independent variables (fat percentage, fat mass, muscle mass, and BMI) were calculated (Table 8). The diagnostic decision-making properties of fat percentage, fat mass, muscle mass, and BMI values in the evaluation of nutrition were examined by Receiver Operating Characteristics (ROC) curve analysis (Figure 1).

Figure 1. ROC Analysis Chart



The cut-off point was determined according to the Youden index. In the presence of significant limit values, the sensitivity, specificity, positive predictive, and negative predictive values of these limits were calculated. The formula for calculating probability with the established logit model is given below. The evaluations made with ROC analysis are shown in Table 9.

$$P(Y = 1 / X = x) = \frac{1}{1 + e^{-(b_0+b_1X_1+b_2X_2+b_3X_3+b_4X_4)}}$$

Table 9. Model probability ROC analysis results

	AU % (%95 CI)	**P**	**Cutting Point**	**Sensitivity**	**Selectivity**	**PPV % (%95 CI)**	**NPV % (%95 CI)**
Model Possibility	85,5 (79,7-91,3)	<0,001	0,4499	87,1 (78,55-93,15)	75,34 (63,86-84,68)	81,8 (74,92-87,12)	82,1 (72,7-88,77)

In predicting nutritional classification, the diagnostic test performance obtained from the probabilities calculated from the model built on four independent variables was found to be statistically significant (AUC=0.855; 95%CI: 0.80-0.91; p<0.001).

Considering the significance of the variability within the model, the Cox & Snell R square value was found to be 0.358 and the Nagelkerle R square value was 0.480.

Discussion

Despite advances in diagnosis and treatment, end-stage renal disease is still an important health problem due to its high mortality and morbidity. HD is the most frequently preferred RRT option all over the world and in our country. According to the TND Registry (2019) report, it is known that the majority of patients receiving HD treatment are male and between the ages of 45 and 64. Although the etiology of ESRD varies by country, it is reported that the most important etiological factors for the development of ESRD in our country are diabetes, hypertension, and glomerulonephritis (TND Registry 2021). The sociodemographic characteristics and etiologies of ESRD development of the patients participating in our study were found to be parallel to the TND Registry 2021.

It has been reported that malnutrition is the most important factor determining poor prognosis and mortality in patients receiving hemodialysis treatment[22,34-38] . It is recommended that some biochemical parameters, such as weight loss, serum albumin, creatinine, lipid profile, BMI, and anthropometric measurements, be used alone or in combination in the evaluation of nutrition in patients receiving hemodialysis treatment[22,23,39,40]. In patients receiving HD treatment, factors such as decreased protein and energy intake, hormonal changes, deterioration of water-salt metabolism, change in calcium-phosphorus balance, and variability in total body water may prevent the correct evaluation of changes in the amount of fat and protein and body composition. Biochemical parameters recommended in the evaluation of nutrition may give incorrect results due to inflammation, liver disease, and hemodialysis treatment. Although anthropometric measurements are a non-invasive, easy-to-apply, and inexpensive method, it is known that they have disadvantages such as the difference in the instruments used, the lack of skill of the individual making the measurement, the area to be measured not being determined correctly, and the characteristics of the individual to be measured[22,40]. Different methods such as evaluation with MIS, and body composition analysis with DEXA or BIA are also used to diagnose nutrition in patients receiving HD treatment[22,23,35,38-40]. The BIA method is a method used clinically in body composition analysis due to its advantages such as being non-invasive, easy to carry and apply, and not giving radiation to the patient[23,37]. In patients receiving HD treatment, the BIA method is recommended to be used in evaluating hydration, urea distribution volume

(UDV), hypervolemi[23,37,40], cardiac performance[36] and determining survival[34] in addition to body component analysis and nutrition evaluation. In addition, it is stated that the BIA method can be applied by dialysis nurses to evaluate patients' dry weight, fluid volume, and nutrition[25,39].

In a study conducted in Korea, where the nutritional status of patients receiving hemodialysis treatment (n=71) was evaluated, it was reported that 24% of the patients had malnutrition[41]. In one study, it was stated that 47.2% of the patients (n=106) receiving HD treatment[42], and in another study, 10.9% of the patients (n=239) had severe malnutrition[43]. Compared to the literature, the rate of malnutrition in our research group was found to be higher than some research results[43] and lower than some research results[41,42,44-47]. This can be explained by the fact that our sample size is different from these studies, different nutritional assessment methods are used in relevant studies, and nutrition varies according to geographical regions and cultures.

According to the Malnutrition Inflammation Score classification, it was determined that the nutrition of female patients was worse than that of male patients. This finding can be explained by the fact that female patients' body muscle mass, hemoglobin value, BMI, and iron binding capacity are lower than male patients, and their fat percentage and fat mass are higher. When our findings were compared with the literature, it was seen that some research findings[43] were different from some similar research findings[42-44]. In the literature, the reason why malnutrition is more common in female patients receiving HD treatment than in male patients is explained by female patients' fluid restrictions and noncompliance with medical nutrition therapy[48,49].

It is emphasized in the literature that low serum levels of hemoglobin, prealbumin, albumin, creatinine, urea, cholesterol, and transferrin are important markers in diagnosing malnutrition in patients receiving HD treatment[50,51]. In this study, it was observed that there was a statistically significant difference between the hemoglobin, albumin, and iron binding levels of patients with good nutritional status and patients with malnutrition. This difference can be explained by the low serum hemoglobin, albumin, and iron binding levels of malnourished patients. In addition, it was determined that there was a statistically significant difference between the BIA parameters of fat percentage, fat mass, muscle mass, and BMI of patients with good nutritional status and patients with malnutrition. This finding can be explained by the low fat percentage, fat mass, muscle mass, and BMI of malnourished patients. It is emphasized in the literature that low serum iron binding and albumin values are associated with malnutrition and high mortality[34-38]. While one study points out that the hemoglobin value is an important indicator in the evaluation of nutrition[42], other studies emphasize that the sensitivity and specificity of the albumin value in the evaluation of nutrition are low[39,52]. According to TND 2021 data, it is stated that 42.3% of patients receiving HD treatment have serum albumin levels of 3.5-4 g/dl, and 21.0% have hemoglobin levels of 10-10.9 g/dl. In our study, albumin levels of malnourished patients were found to be similar to TND 2021 data. This finding supports the need to use different nutritional assessment methods together in diagnosing the nutritional status of patients receiving HD treatment.

The reliability of the BIA method in diagnosing the fluid volume and nutrition of patients receiving hemodialysis treatment has been evaluated in many studies[23,37-39,42,53]. In these studies, correlations between BIA values and biochemical parameters, anthropometric measurements, and MNA or SGA findings were evaluated. In the study of Erdogan et al. (2013) (n=100), it was reported that there was a statistically significant positive correlation between MNA scores, albumin and creatinine values, fat mass, fat percentage, muscle mass, and BMI. In a study (n=106), it was stated that there was a statistically significant positive correlation between hemoglobin value and SGA scores and fat mass, fat percentage, muscle mass, and BMI[42]. In another study (n=173), it was reported that there was a significant positive correlation between serum albumin, prealbumin, anthropometric measurements, and fat mass. Ryu et al. (2019) reported in their study (n=288) that there was a significant positive correlation between SGA scores and BIA values[53].

In this study, unlike the literature, logistic regression analysis was performed between MIS values and BIA measurement parameters. Logistic regression analysis results showed that the test performance of the BIA method was reliable for the diagnosis of nutrition in patients receiving HD treatment. The ROC analysis result showed that the AUC accuracy value of the BIA method was at the "good accuracy level" stated in the literature.

In the literature, studies have been conducted with different BIA analysis devices in the diagnosis of nutrition in patients receiving HD treatment[38,54]. In this study, the cut-off value of the BIA method was 0.44, and the selectivity (75.3%), sensitivity (87.1%), and positive predictive value (81.8%) of the method in diagnosing malnutrition in patients were found to be at an acceptable level. When a body analysis was performed with the BIA method in a patient receiving HD treatment, it was determined that nutritional diagnosis could be made by substituting the values obtained in the established logit model formula. It was seen that if the probability value obtained from the formula was greater than 0.44, it could be interpreted as the patient is malnourished, and if the value was less than 0.44, it could be interpreted as the patient's nutritional status is good.

Conclusion

It showed that there was a significant relationship between the Malnutrition Inflammation Score and BIA measurement parameters and that the selectivity, sensitivity, and positive predictive value of the BIA method in evaluating the nutritional status of patients receiving hemodialysis treatment was at an acceptable level and was a reliable method. It is recommended to use the BIA method in evaluating the nutritional status of patients receiving hemodialysis treatment and in the early diagnosis of malnutrition. Since the BIA method is non-invasive, easy to carry, and clinically reliable results can be obtained, it is recommended that it be applied by hemodialysis nurses and that the nutritional status of patients receiving HD treatment is evaluated with the BIA method, while the hydration of the patients is also evaluated.

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