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NEPHROLOGY - ORIGINAL PAPER

The predictive value of malnutrition for functional and cognitive status in elderly hemodialysis patients

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Abstract

Objective The study aims to objectively and precisely describe, in elderly dialysis patients from a single center, the prevalence of malnutrition and severe cognitive/functional impairment and to establish the prognostic role of malnutrition assessment for patient's severe cognitive/functional status.

Design Cross-sectional study.

Setting A single dialysis center from north-eastern Romania.

Subjects Eighty-one elderly ambulatory hemodialysis patients.

Intervention The aim of the study was to establish in hemodialysis elderly patients a correlation between two malnutrition scores [Mini Nutritional Assessment (MNA) and Subjective Global Assessment (SGA)] and geriatric tests (Geriatric Depression Scale—GDS), daily activities (Activities of Daily Living—ADL, Instrumental Activities of Daily Living—IADL), and cognitive impairment scores (Mini Mental State Examination—MMSE). A correlation between objective malnutrition parameters (bioimpedance lean tissue index (LTI) and fat tissue index (FTI) by bioimpedance) was also assessed.

Main outcome measure Using area under the curve analysis, two malnutrition scores and bioimpedance assessed nutritional status were explored as possible predictors for the most severe category of functional and cognitive status.

Results All patients had mild/moderate malnutrition by SGA, while the MNA test reported malnutrition in 14.5%, and 58% of cases. There was no correlation between subjective scores and objective biomarkers of malnutrition (albumin levels, bioimpedance-derived LTI, FTI). ROC curve analysis showed that MNA and SGA predict the most severe category of depression and functional impairment with relatively good accuracy (specificity, sensibility).

Conclusion The study confirms the important correlation between malnutrition and cognitive/functional impairment and confirms that malnutrition scores could be useful in predicting depression and physical dependance in elderly dialysis patients.

Keywords Malnutrition · Dialysis · Geriatric assessment · Bioimpedance

Introduction

Malnutrition or protein-energy waste (PEW) is a common condition present in elderly patients with comorbidities. Its prevalence varies between 18 and 76% in dialysis populations where it is considered an important negative prognostic factor for the survival of patients with end-stage renal disease (ESRD) [1]. Several factors, such as inadequate food intake, taste alterations and anorexia caused by uremia, concomitant illness, emotional stress, restrictive diets (for heart failure, diabetes mellitus), the dialysis procedure itself (by eliminating specific nutrients), conditions associated with chronic inflammatory condition, anemic syndrome, or endocrine disorders are all involved in the development of malnutrition in elderly [2].

In addition, malnutrition has a negative impact on quality of life—muscle loss and osteoporosis can lead to frequent falls and fractures, with great consequences on patient's autonomy. Furthermore, fat tissue accumulation favors the development of resistance to insulin and consequently, to metabolic syndrome [3]. Findings from recent studies demonstrate that malnutrition is linked, especially in elderly patients, with an increase in morbidity, mortality,

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and hospital stay, with a consequent increase in healthcare costs [4–7].

The correct assessment of nutritional status remains as one of the main challenges in ESRD patients. The current nutrition guidelines on dialysis recommend a set of measurements to improve the precision of the nutritional assessment and the diagnosis of malnutrition [8, 9]. Most of these assessment strategies are common for young and elderly patients. Two of the most used malnutrition scores—the Mini Nutritional Assessment (MNA) and Subjective Global Assessment (SGA)—assess specific conditions present in the aging patient (Table 1); MNA was originally designed for the elderly non-CKD population [10], but most of the recent studies indicated good concurrent validity with other nutritional tests performed in dialysis populations [11]. More recent tools that assess the relative distribution of water vs muscle mass and fat tissue have been utilized to objectively evaluate malnutrition in CKD patients, particularly bioimpedance-derived techniques.

Geriatric patients frequently are depressed and have important reduction in daily activities and cognitive impairment. The study aims to objectively and precisely describe, in elderly dialysis patients from a single center, the prevalence of malnutrition and severe cognitive/functional impairment and to establish the prognostic role of malnutrition assessment for patient's severe cognitive/functional status.

Methods

The aim of the study was to establish in hemodialysis elderly patients a correlation between two malnutrition scores (MNA and SGA) and specific geriatric tests evaluating depression (Geriatric Depression Scale—GDS), daily activities (Activities of Daily Living—ADL, Instrumental Activities of Daily Living—IADL), and cognitive impairment scores (Mini Mental State Examination—MMSE). A correlation between objective malnutrition parameters (lean tissue index (LTI) and fat tissue index (FTI) by bioimpedance) was also assessed.

The inclusion criteria were patients undergoing chronic hemodialysis from a single center, older than 65 years. Patients with < 3 months in dialysis, life expectancy of < 1 year (severe comorbidities, neoplasia), severe cognitive impairment, and refusal to participate were excluded from the study. We assessed 344 patients from a single dialysis center for eligibility. 83 patients older than 65 were identified, 3 being excluded due to severe cognitive impairment (Fig. 1).

In the remaining 81 patients, the following scores and measurements were performed: nutrition assessment scores (SGA and MNA), geriatric assessment scores (ADL, IADL, GDS), and objective anthropometric assessment (weight, height, LTI, FTI—by bioimpedance). All of the questionnaires from the geriatric assessment were completed by patients individually in order to avoid the subjective factor.

Patient demographics, dialysis initiation time, and comorbidities were obtained from a detailed case history and the observation sheet. Muscle strength was evaluated using the electronic dynamometer. The measurements were performed on the arm without venous access. The frailty degree was evaluated through the Fried Frailty Scale. All biochemical measurements were performed by standard methods in the "Dr. C. I. Parhon" "Hospital of Iasi." Serum albumin was measured in all patients prior to the dialysis session. For descriptive statistics, hypoalbuminemia was defined at serum levels below 3.5 mg/dl.

Table 1 SGA and MNA comparison

Parameters	SGA	MNA
Weight loss	✓	✓
Dietary intake	✓	✓
Gastrointestinal symptoms	✓	
Physical function	✓	✓
Comorbidity	✓	
Dialysis vintage	✓	
Physical examination (fat store)	✓	
Physical examination (muscle wasting)	✓	
BMI	✓	✓
Serum albumin	✓	
Mobility	✓	✓
Psychological problems		✓
Neuropsychological issues		✓

SGA Subjective Global Assessment, *MNA* Mini Nutritional Assessment, *BMI* body mass index

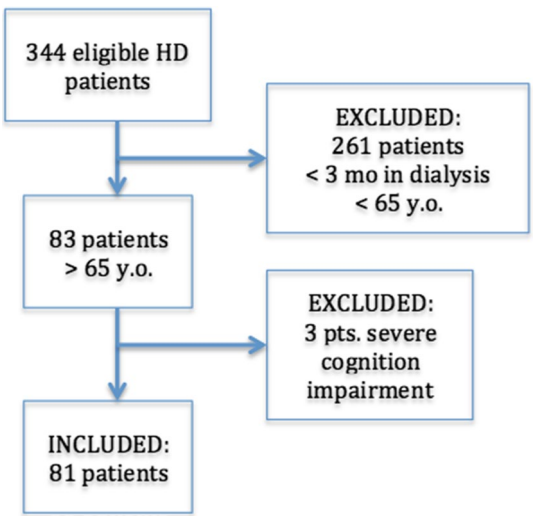

Fig. 1 Flowchart of the study

Mini nutritional assessment

The Mini Nutritional Assessment (MNA) consists of 18 questions related to anthropometric measurements, nutritional intake, global indicators, and self-assessment of health status.

The maximum score is 30 points. Classical values for grouping were 24–30 points—normal nutritional status, 17–23.5 points—at risk of malnutrition, below 17 points—malnourished.

Subjective global assessment

SGA includes nine parameters: weight changes (over the last 6 months), food intake, gastrointestinal symptoms, functional capacity, comorbidities, subcutaneous fat, muscle loss, BMI, serum albumin.

Each component is scored from 0 (normal) to 3 (very severe), so the final malnutrition score varies between 0 (normal) and 27 (severe malnutrition). Low scores denote the trend towards normal nutritional status, a high score being considered an indicator of malnutrition. At the end of this assessment, patients were considered well nourished (0 points), with minor malnutrition (1–8 points), with moderate malnutrition (9–17 points), or severe malnutrition (18–27 points).

Statistics

Statistical analysis was performed using the SPSS version 18.0. Data are expressed in mean and standard deviation or as median and interquartile ranges, depending on the variable's distribution. The concurrent validity was performed by comparing the objective measurements across the groups of nutritional status (treated as categorical variables) assessed by SGA and MNA. Comparisons between the groups of nutritional status assessed by SGA and MNA were tested by the Chi-square test for categorical variables. For continuous variables, differences between the groups were tested either by independent t test or Mann–Whitney U test, as appropriate. The unadjusted and adjusted multivariate Cox regression analysis is presented as hazard ratio (HR; 95% confidence intervals). All results were considered significant if the p value < 0.05.

Results

Descriptive statistics

The demographic characteristics of the patients included in this analysis, according to malnutrition categories, are described in Table 2.

Malnutrition is present in 13.6% and 20.9%, according to SGA and MNA, respectively. There was no significant difference between SGA/MNA-derived nutrition categories and mean (median) albumin levels or BIA-derived lean tissue index (LTI) and fat tissue index (FTI). Thus, Table 2 shows no direct relationship between albumin levels and malnutrition assessment.

Different degrees of depression were found in 79% of patients: 33 patients (40.7%) had moderate depression and 31 (38.3%) a severe form. Different degrees of cognitive impairment, assessed by MMSE, were found in 90% of the patients: 58% with mild and 32.1% with moderate cognitive impairment. Functional impairment was found in between 11% and 37%, according to ADL and IADL, respectively—Table 3.

Distribution of malnutrition according to functional/cognitive scores

The inter-relations between malnutrition and functional scores are described in Table 4. The percentage of patients with severe depression and severe malnutrition was 6.17% and 12.3%, by using SGA and MNA, respectively. The percentage of patients with severe functional scores (ADL, IADL) and severe malnutrition ranged from 7.4% to 12.3% when using SGA and MNA, respectively. Patients with moderate cognitive impairment and malnutrition ranged from 2.46%, by using SGA to 12.34% by using MNA—Table 4.

Correlations between functional/cognitive scores and malnutrition

Linear correlations between (a) cognitive and functional scores and (b) different demographic and anthropometric parameters are summarized in Table 5. Univariate correlations showed that only anthropometric data (height, weight, age, arm circumference, and muscle strength) have a significant correlation with MMSE and IADL scores ($p < 0.05$). No correlation was found between malnutrition assessment and cognitive tests—Table 5.

ROC curve analysis

Using area under the curve analysis, two malnutrition scores (MNA and SGA) and bioimpedance assessed nutritional status (LTI, FTI) were explored, as possible predictors for the most severe category of functional and cognitive status as described by the four geriatric assessment tests performed: ADL (severe), IADL (severe), GDS (severe), and MMSE (moderate). Furthermore, for each

Table 2 Demographic characteristics of the study group

	SGA		*p*	MNA			*p*
	Mild (1–9) *n* = 70	Moderate (10–18) *n* = 11		Well (24–30) *n* = 16	Risk (17–23.5) *n* = 47	Malnutrition (< 17) *n* = 18	
All patients (*n*/%)	70 (86.4%)	11 (13.6%)		16 (19.7%)	48 (59.3%)	17 (20.9%)	
Female (*n* [%])	38 (54.2%)	3 (27.2%)	0.87	7 (43.8%)	25 (53.2%)	9 (50%)	0.75
Male (*n* [%])	32 (45.8%)	8 (72.8%)		9 (56.2%)	22 (46.8%)	9 (50%)	
Age (years)	74.02 ± 6.17	73 ± 5.62	0.04	73.68 ± 6.12	73.35 ± 6.17	75.58 ± 5.79	0.6
Dialysis length (m)	45 (21;62)	83 (19;105)	0.6	69 (20;90)	45 (23;69)	28 (18;59)	0.67
Diabetes (*n* [%])	4 (5.7%)	0 (%)	0.42	1 (6.2%)	3 (6.3%)	0 (0%)	0.57
Cardiac failure (*n* [%])	29 (41.4%)	4 (36.3%)	0.75	4 (2.5%)	20 (42.5%)	9 (50%)	0.043
Hypertension (*n* [%])	31 (44.2%)	3 (27.2%)	0.29	6 (37.5%)	18 (38.2%)	10 (55.5%)	0.60
Weight (kg)	69.6 ± 16	76.6 ± 11	0.2	73.4 ± 13.81	69.2 ± 15.6	71.5 ± 17.6	0.58
BMI (kg/m^2)	26.5 ± 5.3	28.7 ± 5	0.068	27.8 ± 4.7	26.5 ± 5.4	26.7 ± 5.6	0.13
HGS (kg)	14.8 ± 8	21.6 ± 8.5	0.072	17.7 ± 8.7	15.1 ± 9.1	17.5 ± 7.7	0.21
Calf circumf (cm)	24 ± 1.6	23.8 ± 2.1	< 0.001	24.1 ± 2.3	23.9 ± 1.8	24 ± 1	< 0.001
Albumin (g/dL)	4.69 ± 0.53	4.69 ± 0.44	0.97	4.71 ± 0.54	4.69 ± 0.47	4.63 ± 0.65	0.49
Hemoglobin (g/dL)	11.4 ± 1.7	11.1 ± 1.1	0.43	11.5 ± 1.3	11.3 ± 1.8	11.6 ± 1.5	0.71
FTI	15.7 ± 5.8	12.8 ± 5.8	0.2	16.9 ± 5.3	15.3 ± 5.8	13.5 ± 6.7	0.66
LTI	11.4 ± 2.44	11 ± 2.2	0.72	11 ± 2.2	11.5 ± 2.6	11.4 ± 2.3	0.77

Mean ± standard deviation or median (25th;75th percentile), as appropriate

SGA Subjective Global Assessment, *MNA* Mini Nutritional Assessment, *BMI* body mass index, *HGS* hand grip strength, *LTI* lean tissue index, *FTI*, fat tissue index

Table 3 Distribution of patients according to malnutrition, cognitive, and functional scores

n = 81	MMSE	GDS	ADL	IADL
Normal	8 (9.9%)	17 (21%)	30 (37%)	14 (17.3%)
Mild	47 (58%)	33 (40.7%)	42 (52%)	37 (45.7%)
Moderate	26 (32.1%)	31(38.3%)	9 (11%)	30 (37%)

MMSE Mini Mental State Examination, *GDS* Geriatric Depression Scale, *ADL* activities of daily living, *IADL* Instrumental activities of daily living

nutrition assessment tool, cut-off analysis was performed to determine the cut-off point with optimal specificity and sensitivity; see Table 6.

Only MNA (AUC = 0.856) and SGA (AUC = 0.897) had very good accuracy in identifying patients with severe ADL. A value < 19 points derived from the MNA score offers an 88.9% sensitivity and 75% specificity, while a SGA score of above 8 offers 77.8% sensitivity and 91.7% specificity.

MNA (AUC = 0.776) had a good accuracy for identifying patients in the severe GDS category. A MNA score of under 19 points has 52.6% sensitivity and 88.1% specificity for severe GDS; see Table 6 and Fig. 2.

Bioimpedance-derived parameters of malnutrition (LTI, FTI) had no predictive power for advanced physical dependance and severe depression in the selected population.

Summary of findings

In elderly patients from a single dialysis center, severe malnutrition was present in 13.6% and 20.9% of patients, according to SGA and MNA, respectively. MMSE score showed that 32.1% of patients had cognitive impairment, depression was found in 38.3%, and functional impairment was found in 11–37% of elderly patients.

According to SGA and MNA, severe malnutrition and moderate cognitive impairment was found in 2.46% and 12.34% patients, severe malnutrition and depression in 6.17% and 12.3%, and severe malnutrition and the lowest functional category in 7.4–12.3% of patients.

There was no correlation between subjective scores and objective biomarkers of malnutrition (albumin levels, bioimpedance-derived LTI, FTI).

ROC curve analysis showed that only MNA and SGA predict, with relatively good accuracy (specificity, sensibility) the most severe category of depression and functional impairment.

Table 4 Categories of functional and cognitive scores according to malnutrition assessment. (% of all patients)

	SGA		MNA		
	Mild (score = 1–9)	Moderate (score = 10–18)	Well (score = 24–30)	Risk (score = 17–23.5)	Malnutrition (score < 17)
	n from each category % of all patients		*n* from each category % of all patients		
MMSE	*n* = 70	*n* = 11	*n* = 16	*n* = 48	*n* = 17
Normal	7 (8.6%)	1 (1.2%)	3 (3.7%)	5 (6.17%)	0 (0%)
Mild	39 (48.1%)	8 (9.8%)	11 (13.6%)	29 (35.8%)	7 (8.6%)
Moderate	24 (29.6%)	**2 (2.46%)**	2 (2.46%)	14 (17.3%)	**10 (12.34%)**
GDS					
Normal	16 (19.75%)	1 (1.2%)	4 (5%)	9 (11.1%)	1 (1.2%)
Moderate	28 (34.56%)	5 (6.17%)	11 (13.6%)	19 (23.45%)	6 (7.4%)
Severe	26 (30%)	**5 (6.17%)**	1 (1.2%)	20 (24.6%)	**10 (12.34%)**
ADL					
Normal	47 (58%)	2 (2.46%)	10 (12.34%)	19 (23.45%)	1 (1.2%)
Moderate	20 (24.7%)	3 (3.7%)	6 (7.4%)	26 (30.1%)	10 (12.34%)
Severe	3 (3.7%)	**6 (7.4%)**	0 (0%)	3 (3.7%)	**6 (7.4%)**
IADL					
Normal	14 (17.28%)	0 (%)	5 (6.17%)	7 (8.6%)	1 (1.2%)
Moderate	34 (42%)	3 (3.7%)	9 (11.11%)	22 (27.16%)	6 (7.4%)
Severe	22 (27.16%)	**8 (9.8%)**	2 (2.46%)	18 (22.22%)	**10 (12.34%)**

Bold values indicate significant correlation ($p < 0.05$)

SGA Subjective Global Assessment, *MNA* Mini Nutritional Assessment, *MMSE* Mini Mental State Examination, *GDS* Geriatric Depression Scale, *ADL* activities of daily living, *IADL* Instrumental activities of daily living

Table 5 Linear correlations between anthropometric, malnutrition scores, and geriatric assessment (cognitive and functional scores)

	MMSE		ADL		IADL		GDS	
	r	*p*	*r*	*p*	*r*	*p*	*r*	*p*
Age	**−0.437****	**0.01**	−0.063	0.574	**−0.398****	**0.01**	0.004	0.971
Dialysis duration	−0.122	0.277	0.061	0.592	−0.067	0.55	0.123	0.275
Height	**0.276***	**0.012**	0.052	0.645	**0.297****	**0.007**	0.062	0.582
Weight	**0.326****	**0.003**	0.099	0.38	**0.223***	**0.045**	0.04	0.723
SGA	0.055	0.627	0.051	0.652	0.025	0.826	0	0.999
MNA	−0.08	0.478	0.135	0.229	−0.014	0.901	0.05	0.657
LTI	−0.178	0.113	−0.083	0.461	−0.024	0.831	0.108	0.336
FTI	0.138	0.218	0.177	0.113	0.091	0.421	−0.069	0.542
Frailty	0.091	0.421	0.157	0.162	0.114	0.309	−0.114	0.31
Arm circumference	**0.230***	**0.039**	**0.242***	**0.029**	**0.254***	**0.022**	0.01	0.928
Muscle strength	**0.389****	**0.01**	0.172	0.124	**0.414****	**0.01**	**−0.260***	**0.019**
Hemoglobin	−0.203	0.071	0.02	0.86	**−0.232***	**0.039**	−0.056	0.62

Bold values indicate significant correlation ($p < 0.05$)

MMSE Mini Mental State Examination, *ADL* activities of daily living, *IADL* Instrumental activities of daily Living, *GDS* Geriatric Depression Scale, *SGA* Subjective Global Assessment, *MNA* Mini Nutritional Assessment, *LTI* lean tissue index, *FTI* fat tissue index

*$p < 0.05$

**$p < 0.01$

Table 6 Area under the curve and cut-off analysis

	MNA	SGA	FTI	LTI
ADL (severe)				
AUC	**0.856**	**0.897**	0.665	0.575
95% CI	0.760–0.924	0.810–0.954	0.552–0.766	0.460–0.684
Cut-off (sensitivity/specificity)	≤19 (88.89%, 75%)	>8 (77.78%, 91.67%)		
IADL (severe)				
AUC	0.658	0.638	0.52	0.692
95% CI	0.544–0.760	0.524–0.742	0.406–0.633	0.579–0.790
Cut-off (sensitivity/specificity)	≤17.5 (43.33%, 84.31%)	>8 (30%, 92.16%)		
GDS (severe)				
AUC	*0.776*	0.674	0.522	0.513
95% CI	0.669–0.862	0.560–0.775	0.408–0.635	0.398–0.626
Cut-off (sensitivity/specificity)	≤19 (52.63%, 88.1%)	>5 (60.53%, 64.29%)		
MMSE (moderate)				
AUC	0.661	0.636	0.633	0.542
95% CI	0.548–0.763	0.522–0.740	0.518–0.737	0.428–0.654
Cut-off (sensitivity/specificity)	≤15.5 (34.62%, 94.55%)	>9 (30.77%, 94.55%)		

MNA Mini Nutritional Assessment, *SGA* Subjective Global Assessment, *LTI* lean tissue index, *FTI* fat tissue index, *ADL* activities of daily living, *IADL* Instrumental activities of daily living, *GDS* Geriatric Depression Scale, *MMSE* Mini Mental State Examination

Italics—good accuracy, bold—very good accuracy

Discussion

One of the most common complications that occur in hemodialysis patients, with a significant negative impact on quality of life, is malnutrition. Often overlooked or underestimated, it is clearly associated with increased mortality risk. Nutritional evaluation of dialysis geriatric patients remains a challenge for clinicians, all the more so, as there are a small number of studies that include this age group. Research over the past decade promotes two subjective tests: MNA and SGA to complete comprehensive geriatric assessment.

In the present study, the prevalence of malnutrition varied according to the tests used: all patients had mild/moderate malnutrition by SGA, while the MNA test reported malnutrition in 14.5%, and 58% of cases. Previous studies reported lower rates of malnutrition using SGA (31–75%) [12], but such variations may be a consequence of different assessment methods and of included patients (elderly from a lower socio-economic region—N-E Romania) [13, 14].

Our study, could not emphasize a strong association between nutritional status and serum albumin: in 97.6% of patients, this biomarker was within normal limits. Serum albumin has been shown to be a poor predictor of nutritional status [15–17]; therefore, some studies even suggested to reconsider serum albumin as a marker of disease rather than the nutritional status [18].

The geriatric evaluation performed showed an increased prevalence of depression among the patients enrolled (79%). Numerous previous studies reported that depression influences individual response to treatment, patient's compliance, and is associated with increased pro-inflammatory cytokine levels and malnutrition risk [19]. Both the degree of cognitive impairment and the dependence on performing instrumental activities for daily living correlated with age, anthropometric measurements, and muscle strength.

The most important finding derived from our study is the predictive power of nutrition assessment tests (MNA, SGA) for advanced stages of physical dependence, MNA being the best predictor of severe depression (as determined by ADL and GDS scores). MNA and SGA were found to have the best prediction power for severe functional impairment (assessed by ADL): AUC of 0.856 and 0.897 for MNA and SGA, respectively, while bioimpedance-derived malnutrition parameters (FTI, LTI) were not useful in predicting severe cognitive and functional impairment.

Practical application

Taking into account the limitations of the study (cross-sectional assessment of a small number of patients from a single dialysis center), we believe this is one of the first studies that uses objective and subjective instruments (two malnutrition scores as pe guidelines, complete geriatric assessment, albumin, and bioimpedance) in the same geriatric population. The study confirms the important correlation between malnutrition and severe cognitive/functional impairment and confirms that malnutrition scores could be

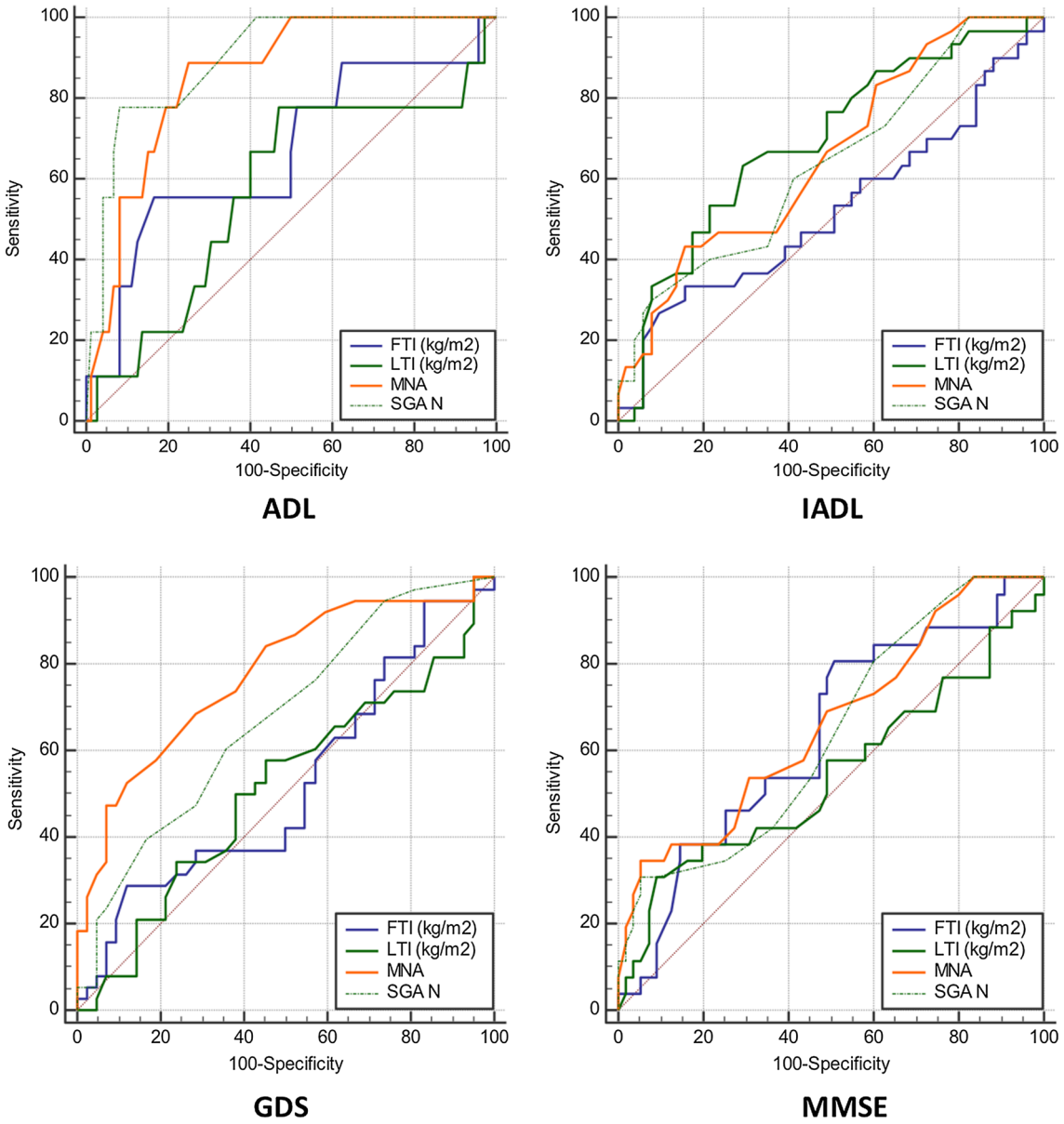

Fig. 2 ROC curves for FTI, LTI, MNA, and SGA scores as predictors for severe ADL, IADL, GDS, and MMSE

useful in predicting, with relatively good accuracy, depression and physical dependance in elderly dialysis patients.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

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