IS NRS-2002 A RELIABLE TOOL IN THE NUTRITIONAL ASSESSMENT OF CIRRHOSIS: A COMPARATIVE STUDY

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ABSTRACT

Introduction*: Nutritional assessment of cirrhotic patients is a neglected issue. This study compared cirrhotic and non-cirrhotic subjects in terms of nutritional assessment tools and investigated the relationship between nutritional risk screening (NRS)-2002 and subjective global assessment (SGA) with other nutritional assessment parameters.*

Materials and methods*: Fifty-seven cirrhotic patients (age 59±13 years, 63% male) and 58 control subjects (age 63±11, 52% male) were recruited. Anthropometry, bioelectrical impedance analysis and hand grip strength measurements were recorded. Nutritional status was evaluated by NRS-2002 and SGA.*

Results*: While none of the controls had malnutrition, prevalences of malnutrition were 37% by NRS-2002 and 74% by SGA among cirrhotic patients. Dry body mass index (BMI) (28.0±6.2 kg/m2 vs. 30.1±5.1 kg/m2, p=0.04), mid-arm circumference (MAC) (29.1±5.1 cm vs. 30.8±3.0 cm, p=0.03) and triceps skinfold thickness (TST) (19.9±9.6 mm vs. 25.3±8.1 mm, p=0.003) were lower and total body water (TBW) was higher (51.1±8.9% vs. 47.5±6.9%, p= 0.018) in cirrhotic group compared to controls. Malnutrition by NRS-2002 was negatively correlated with dry BMI (r=-0.416 ,p=0.001), MAC (r=-0.515 ,p<0.001) and TST (r=-0.528 ,p<0.001) and positively correlated with TBW (r=0.273, p=0.04). Malnutrition by SGA was correlated only with TST (r=-0.286, p=0.031). The AUROC curves of dry BMI, MAC and TST were 0.75, 0.81 and 0.82 to discriminate the presence or absence of malnutrition by NRS-2002.*

Conclusion*: Since it is correlated with other nutritional assessment tools, NRS-2002 may be used in the assessment of cirrhotic subjects.*

Key words*: Anthropometric measurements, cirrhosis, malnutrition, nutritional risk screening-2002, subjective global assessment.*

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Introduction

Malnutrition is a common condition in liver cirrhosis that ranges from one-third among compensated patients to 60-90% in decompensated cirrhosis[(1)]. Several mechanisms have been defined to explain the development of malnutrition in end stage liver disease (ESLD), such as anorexia, impaired dietary intake, malabsorption, intestinal protein loss, defect in the hepatic synthesis of carbohydrates, protein and fat, alterations in the utilization of nutrients, systemic inflammation, hypermetabolism and increased β-adrenergic activity[(2-4)]. Malnutrition in cirrhosis is related to higher prevalence of complications, longer hospital stays and more postoperative complications among patients who undergo liver transplantation[(5-7)]. Furthermore, earlier studies have demonstrated that malnutrition is an independent predictor of mortality in cirrhotic subjects[(7,8)].

Nutritional assessment tools can be divided into four categories:

• laboratory parameters (albumin, prealbumin, retinol binding protein, total lymphocyte count and measurements of micronutrients and vitamins, and so on);

• body composition (BC) measurements [anthropometric measurements including body mass index (BMI), waist circumference, hip circumference, waist to hip ratio, mid-arm circumference (MAC), skinfold thickness, mid-arm muscle circumference (MAMC), dry BMI, and so on];

• measurements of muscle mass and functionality (hand grip strength, gait speed) strength;

• nutritional assessment tests, including nutritional risk screening 2002 (NRS-2002) and subjective global assessment (SGA)[2,5,9].

The primary aim of this study is to compare several different nutritional assessment parameters in patients with cirrhosis and controls.

The secondary aim of the study was to analyze the potential relationship of the NRS-2002 and SGA with anthropometry and BC measurements and to determine the values for use as a clinical tool in the assessment of patients with cirrhosis.

Materials and methods

Study population

A total of 57 patients who were admitted to Istanbul Umraniye Education and Research Hospital between with a diagnosis of cirrhosis were enrolled in the study. Diagnosis of cirrhosis was based on clinical and laboratory findings, radiologic findings and pathological diagnosis, if available. Cirrhotic patients who had hepatocellular carcinoma (HCC) or any other malignancy were excluded. Being less than 18 years old and being pregnant were the other exclusion criteria. Laboratory examinations, including a complete blood count, liver function tests, albumin, blood urea nitrogen, creatinine, prothrombin time and INR, were recorded. Patients with cirrhosis were evaluated for disease severity with Child-Turcotte-Pugh (CTP) and model for end-stage liver disease (MELD). The control group was composed of 58 age- and sex-matched people without chronic liver disease but with other chronic disorders.

This study was approved by Instituional Review Board of Umraniye Education and Research Hospital (Reference number: 20148) and informed consent was obtained from all participants.

Anthropometric measurements

Height was measured to the nearest 0.1 cm without shoes using a stadiometer (G-tech, Gyeonggi-do, South Korea). Body weight was measured to the nearest 0.1 kg using an electronic scale (Tanita Ultimate Scale; Model 2000, Tanita Corp., Tokyo, Japan), with subjects wearing only underwear, no shoes and having removed all metal and jewelry. The body mass index (BMI) was computed as body weight (kg)/height (m^2). The participants were assessed for the presence and severity of ascites using ultrasound in addition to the clinical assessment of pedal edema. Dry body weight was calculated by subtracting 5% of the body weight for mild ascites, 10% for moderate ascites, and 15% for severe ascites, with an additional 5% of the body weight subtracted in the presence of bilateral pedal edema, as reported by Tandon et al.[10]. These were used to calculate the dry BMI according to the formula (Dry) weight (kg) / height (m^2). The waist circumference was measured with a non-stretchable measuring tape at the midpoint between the lower edge of the rib cage and the iliac crests. The waist circumference was defined as the smallest circumference measured at the navel, and the hip circumference was defined as the largest circumference measured at the hips and buttocks. The waist-to-hip ratio (WHR) was determined as the waist circumference divided by the hip circumference.

The mid-arm circumference (MAC) (cm) was measured at the midpoint between the tip of the acromion and the olecranon process with a non-flexible tape. A skinfold measurement was determined at triceps area (mm) (TST) using a Saehan Skinfold Fat Calipper (Saehan Corp., Masan, South Korea) with a pressure of 10 g/mm^3 applied to the surface area. The average of three consecutive readings was recorded. All the readings were carried out by the same operator (YP). All the measurements were performed at the non-dominant arm, with the patients standing in a relaxed position, Mid-arm muscle circumference (MAMC) was calculated by the formula: $MAMC = MAC - (\pi \times TST)$. Mid-arm muscle area (MAMA) was calculated using the MAC and TSF according to the following equations: MAMA (cm^2) = $[MAC - (\pi \times TST)]2/4\ \pi$.

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Bioelectrical Impedans Analysis (BIA)

The body composition (BC) was assessed using a single frequency impedance BC analyzer (Tanita brand, model BC-420MA, Tanita Corp., Tokyo, Japan). After entering the height, age and sex into the Bioelectrical Impedans Analysis (BIA) equipment, the subject stood in an upright position with bare feet on the analyzer footpads. The impedance between the two feet was measured while an alternating current (50/60 kHz and 90 mA) was passed through the lower body. As mentioned earlier, the weight was measured. This equipment also provides estimated values for the fat mass (FM), fat-free mass (FFM), muscle mass (MM) and total body weight (TBW). The measurements were taken after an overnight fast.

Hand grip strength measurement

Hand grip strength (HGS) was measured by a mechanical handgrip dynamometer (Takei Strength Dynamometer, Takei Scientific Instruments Co. Ltd., Niigita, Japan). A hand was placed on an armrest at a 30-degree angle, and the HGS was tested. The maximum value of 3 consecutive measurements with a one-minute recovery between attempts from both the dominant hand and non-dominant hand was noted. Accounting for the sex differences at the HGS measurements, sex-specific analysis was performed.

Subjective global assessment (SGA)

The SGA was conducted according to the nutritional status (weight loss, dietary intake and gastrointestinal symptoms) and clinical examination (physical signs of malnutrition, such as depletion of subcutaneous fat and muscle mass) of the patients[11]. The patients were classified as those with well-nourished or anabolic (SGA-A), those with moderate undernutrition (SGA-B) and those with severe undernutrition (SGA-C).

Nutritional risk screening 2002 (NRS-2002)

The NRS-2002 has been using for screening and evaluation of nutrition status in hospitalized patients.12. It is based on BMI, percentage of recent weight loss, recent change in food intake, disease severity and over 70 years old. When the final score is ≥3 points, the patient is considered at nutrition risk.

Statistical Analysis

Statistical analyses were carried out using SPSS (version 21; SPSS Inc., Chicago, Illinois, USA). The variables were analyzed using the Kolmogorov-Smirnov test and Shapiro–Wilk's test to check the normality. Nominal data were expressed as number (percent). Continuous variables with a normal distribution were represented as mean ±SD, those with a non-normal distribution and ordinal variables were described as median ± SE or interquartile range. A chi-square test was used for categorical variables. The Student t-test was used for normally distributed parameters, whereas for non-normally distributed factors, the Mann Whitney U test was used for comparison between two groups. Spearman's correlation coefficients (r) were calculated to evaluate the correlation between nutritional assessment tools including NRS-2002 and SGA with anthropometric measurements and body composition analysis measurements. The ability of each nutrition assessment parameter to predict nutritional risk by NRS-2002 was investigated by receiver operating characteristics (ROCs) analysis. The significant value with the best level of sensitivity and also specificity in the area under the curve analysis was selected as the ideal cut-off. Whenever a significant cut-off value was found, the sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) were determined. A p value of <0.05 was considered statistical significant.

Results

A total of 57 patients with cirrhosis and 58 age- and sex-matched control subjects were compared. Demographic clinical and laboratory features were given in Table 1. The mean ages were 59±13 years in the cirrhotic group and 63±11 years in the control group (p=0.07). The male-to-female ratio also did not differ between the patients with cirrhosis and the control subjects (36/21 vs 30/28, p=0.21).

Although Type 2 diabetes mellitus (DM) and hypertension (HT) were found to be similar between the two groups (both p>0.05), ischemic heart disease was more prevalent among patients with cirrhosis (21%) compared to control subjects (7%) (p=0.03). In the cirrhotic group, according to CTP, 35% of the participants were in group A, 42% in group B and 23% in group C. The median MELD score was 13±6.5. Chronic hepatitis B (28%), non-alcoholic steatohepatitis (NASH) (16%) and chronic hepatitis C (14%) were common identifiable etiologic factors for cirrhosis. On the other hand, 33% of the cirrhotic patients were assessed as cryptogenic.

The comparison of the groups according to the nutritional assessment tools is given in Table 2. While the mean BMI of the patients with cirrhosis and BMI of the control subjects were not different (30.1±6.7 vs. 30.2±5.1, p=0.59), the dry BMI of the cirrhotic subjects was lower than that of the control subjects (28.0±6.2 vs. 30.1±5.1, p=0.04). Other different anthropometric measurements between the two groups were MAC and TST, which were higher in the control subjects compared to the cirrhotic group (for MAC 30.8±3.0 vs. 29.1±5.1, p=0.03, and for TST 25.3±8.1 vs. 19.9±9.6, p=0.003).

The body fat ratio, fat free mass and muscle mass did not differ between the patients with cirrhosis and the control subjects (for all, p>0.05). The only different BIA parameter between the groups was TBW. As expected, the mean TBW was higher in the patients with cirrhosis than in the control subjects (51.1±8.9% vs. 47.5±6.9%, p= 0.018).

	Patients with cirrhosis(n=57)	Control subjects (n=58)	P
Age, mean±SD	59±13	63±11	0.07
Sex (Male/Female)	36/21	30/28	0.21
Chronic disorders, n (%)			
Diabetes Mellitus	21 (37)	19 (33)	0.64
Hypertension	18 (31)	27 (47)	0.10
Ischemic heart disease	12 (21)	4 (7)	**0.03**
COPD	3 (5)	2 (3)	0.68
Chronic renal failure	1 (2)	0 (0)	0.49
Hypothyroidism	5 (9)	5 (9)	1.00
Duration of cirrhosis, median (IQR)	27 (35)		
Etiology, n (%)			
HBV	16 (28)		
HCV	8 (14)		
Cryptogenic	19 (33)		
Non-alcoholic steatohepatitis	9 (16)		
Alcoholic steatohepatitis	3 (5)		
Other	4 (7)		
Child-Turcotte-Pugh, n (%)			
Class A	20 (35)		
Class B	24 (42)		
Class C	13 (23)		
MELD , median (IQR)	12 (7)		

Table 1: Demographic and clinical features of patients with cirrhosis and control subjects.

The right hand grip strength measurements were lower in patients with cirrhosis for women (14.8±1.1 vs. 20.1±1.1, p=0.006) and men (28.3±1.8 vs. 34.9±1.5, p=0.003). Similar results were found in the left-hand grip strength measurements for women (15.5±1.0 vs. 18.7±1.1, p=0.019) and men (26.8±1.8 vs. 34.7±1.3, p<0.001).

The groups were compared according to the nutritional screening tools by NRS-2002 and SGA. While none of the control subjects had nutritional risk according to NRS-2002, 37% of the patients with cirrhosis had nutritional risk (p < 0.001). According to the SGA questionnaire, while all of the control subjects were well-nourished, 53% of the cirrhotic subjects were moderately malnourished, and 21% of them were severe malnourished (p<0.001). Only 26% of the cirrhotic patients were well-nourished.

	Patients with cirrhosis(n=57)	Control subjects (n=58)	P
Anthropometric measurements			
Height (cm)	164±9	164±10	0.95
Body weight (kg)	81±18	81±13	1.0
BMI (kg/m²)	30.1±6.7	30.2±5.1	0.59
Dry BMI (kg/m²)	28.0±6.2	30.1±5.1	**0.04**
Waist circumference (cm)	108±14	105±10	0.17
Hip circumference (cm)	106±13	108±10	0.61
Waist / hip ratio	0.99±0.16	0.95±0.02	0.44
MAC (cm)	29.1±5.1	30.8±3.0	**0.03**
TST (mm)	19±1.3	26.5±1.1	**0.003**
MAMC (cm)	22.8±3.1	22.9±2.0	0.92
MAMA (cm²)	42±11	42±7	0.84
Bioimpedance Analysis			
Body fat ratio (%)	25.0±1.6	31.9±1.3	0.07
Fat-free mass (kg)	57.4±11.4	55.1±10.2	0.26
Muscle mass (kg)	54.5±10.9	52.3±9.8	0.23
Total body water (%)	51.1±8.9	47.5±6.9	**0.018**
Right hand grip strength (kg)			
Female	14.8±1.1	20.1±1.1	**0.006**
Male	28.3±1.8	34.9±1.5	**0.003**
Left hand grip strength (kg)			
Female	15.5±1.0	18.7±1.1	**0.019**
Male	26.8±1.8	34.7±1.3	**<0.001**
NRS-2002			
Without nutritional risk, n (%)	36 (63)	58 (100)	
With nutritional risk, n (%)	21 (37)	0 (0)	
SGA			**<0.001**
Well-nourished or anabolic, n (%)	15 (26)	58 (100)	
Moderate undernutrition, n (%)	30 (53)	0 (0)	
Severe undernutrition, n (%)	12 (21)	0 (0)	

Table 2: Comparison of patients with cirrhosis and control subjects according to the nutritional assessment parameters including; anthoropometric measurements, bioelectrical impedance analysis, hand grip strength test, NRS-2002 and SGA.

	NRS-2002		SGA	
	r	p	*r*	p
BMI (kg/m²)	**-0.331**	**0.012**	-0.039	0.775
Dry BMI (kg/m²)	**-0.416**	**0.001**	-0.216	0.107
Waist circumference (cm)	-0.126	0.350	0.110	0.414
Hip circumference (cm)	**-0.317**	**0.016**	-0.113	0.404
Waist / hip ratio	0.250	0.061	0. 166	0.216
MAC (cm)	**-0.515**	**<0.001**	-0.185	0.169
TST (mm)	**-0.528**	**<0.001**	**-0.286**	**0.031**
MAMC (cm)	**-0.334**	**0.011**	-0.038	0.782
MAMA (cm²)	**-0.334**	**0.011**	-0.038	0.782
Right HGS, female (kg)	0.204	0.375	0.299	0.189
Right HGS, male (kg)	-0.180	0.292	0.025	0.886
Left HGS, female (kg)	0.151	0.525	0.063	0.792
Left HGS, male (kg)	-0.195	0.255	0.074	0.668
Body fat ratio (%)	**-0.280**	**0.035**	-0.117	0.384
Fat-free mass (kg)	-0.141	0.294	0.147	0.277
Muscle mass (kg)	-0.141	0.294	0.147	0.277
Total body water (%)	**0.273**	**0.040**	0.136	0.314
CTP	**0.344**	**0.009**	-0.129	0.340
CTP score	**0.433**	**0.001**	0.008	0.956
MELD score	**0.261**	0.050	0.078	0.564

Table 3: Association of malnutrition by NRS-2002 and by SGA with anthropometric measurements, bioelectrical impedance parameters, and hand grip strength test.

The correlations between the malnutrition according to the nutritional assessment tools (NRS-2002 ≥3 or SGA B and SGA C) and anthropometric measurements, BC analysis and hand grip strength measurements in the cirrhotic group are given in Table 3. There was a significant positive correlation between the total body water and nutritional risk according to NRS-2002 (r=0.273, p=0.04). In addition, there were significant negative correlations of malnutrition according to NRS-2002 with BMI (r=-0.331, p= 0.012); dry BMI (r=-0.416, p=0.001); hip circumference (r=-0.317, p=0.016); MAMC (r=-0.334, p=0.011); MAMA (r=-0.334, p=0.011); and a highly significant correlation with MAC (r=-0.515, p<0.001) and TST (r=-0.528, p<0.001). The correlation with undernutrition according to SGA was found only with TST (r=-0.286, p=0.031). Other anthropometric and BC measurements were not significantly correlated. In the comparison of nutritional assessment tools among cirrhotic patients according to the malnutrition risk in terms of NRS-2002, weight, BMI, dry BMI, hip circumference, MAC, MAMC, MAMA, TST and body fat ratio values were higher in non-nutritional risk group (for all, p<0.05). On the other hand, total body water was higher in nutritional risk group according to NRS-2002 (53.9±2.1 vs. 49.0±1.3, p=0.041). Values were given in Table 4.

	Non-nutritional risk group (n=36)	Nutritional risk group (n=21)	P
Anthropometric measurements			
Height (cm)	165±2	165±2	0.78
Body weight (kg)	81±3	69±4	**0.012**
BMI (kg/m²)	29.9±1.0	26.1±1.6	**0.013**
Dry BMI (kg/m²)	28.7±0.8	22.6±1.5	**0.002**
Waist circumference (cm)	107±2.4	107±2.8	0.34
Hip circumference (cm)	108±1.8	101±3.0	**0.018**
Waist / hip ratio	0.96±0.01	1.02±0.24	0.06
MAC (cm)	31.5±0.7	26.0±1.1	**<0.001**
TST (mm)	24±1.3	10±1.9	**<0.001**
MAMC (cm)	24.0±0.5	22.2±0.7	**0.012**
MAMA (cm²)	46.0±1.8	41.2±2.1	**0.012**
Bioimpedance Analysis			
Body fat ratio (%)	30.5±1.8	23.0±2.6	**0.036**
Fat-free mass (kg)	57.7±2.1	54.6±2.1	0.29
Muscle mass (kg)	54.8±2.0	51.8±2.0	0.29
Total body water (%)	49.0±1.3	53.9±2.1	**0.041**
Right hand grip strength (kg)			
Female	14.5±1.2	17.1±2.1	0.42
Male	29.9±2.5	25.7±2.3	0.28
Left hand grip strength (kg)			
Female	14.9±1.0	18.1±1.7	0.42
Male	28.0±2.4	22.4±2.5	0.21

Table 4: Comparison of nutritional assessment parameters among cirrhotic patients according to the NRS-2002.

We assessed the diagnostic ability of the anthropometric measurements and BC parameters in predicting to have or not nutritional risk according to NRS-2002 by area under receiver operating characteristic (AUROC). The AUROC analysis suggested that dry BMI (AUROC: 0.75; 95%CI: 0.60-0.90, p=0.002), MAC (AUROC: 0.81; 95%CI: 0.68-0.93, p<0.001) and TST (AUROC: 0.82; 95%CI: 0.69-0.95, p<0.001) had superior diagnostic accuracy compared to other statistically significant parameters, including the BMI (AUROC: 0.70; 95%CI: 0.54-0.85, p=0.013), hip circumference (AUROC: 0.69; 95%CI: 0.54-0.84, p=0.018), body fat ratio (AUROC: 0.67; 95%CI: 0.51-0.82, p=0.036), MAMC (AUROC: 0.70; 95%CI: 0.56-0.84, p=0.012) and MAMA (AUROC: 0.70; 95%CI: 0.56-0.84, p=0.012). Inversely, the AUROC of the total body water was statistically significant to differentiate those with malnutrition according to NRS-2002 (AUROC: 0.66; 95%CI: 0.51-0.81, p=0.041).

The AUROCs, sensitivity, specificity, PPV and NPV values for MAC, TST and dry BMI at optimal cut-off points are given in Table 5. A cut-off point of 28.5 cm for MAC has the highest sensitivity (77.8%) and specificity (77.2%). Similarly, at a cut-off point of TST (18.5 mm), the sensitivity and specificity were 72.2% and 77.2%, respectively. For dry BMI, the optimal cut-off point was 26.8 kg/m^2 with a sensitivity of 75.0% and a specificity of 71.4%.

	AUROC (95% CI)	Sensitivity (%)	Specificity (%)	PPV	NPV
MAC	0.81(0.68-0.93)	77.8	77.2	84.8	66.7
TST	0.82 (0.69-0.95)	72.2	77.2	83.9	61.5
Dry BMI	0.75 (0.60-0.90)	75.0	71.4	81.8	62.5

Table 5: Diagnostic performances of MAC, TST and dry BMI for discrimination of malnutrition according to NRS-2002.

Discussion

Previous studies have focused on the role of malnutrition as an independent risk factor on survival and the development of the cirrhosis-related complications such as variceal bleeding, ascites and hepatic encephalopathy in patient groups with cirrhosis[1, 8, 13-15]. There are scarce data about the comparison of BC measurements and nutritional assessment tools between patients with cirrhosis and non-cirrhotic subjects. In the current study, several nutritional assessment tools were compared in cirrhotic and non-cirrhotic groups, and the relationship between these different parameters was investigated.

The present study showed that while malnutrition was not evident according to NRS-2002 and SGA among the control subjects, malnutrition in patients with cirrhosis was 37% according to NRS-2002 and 74% according to SGA. SGA has been the most widely studied nutritional assessment tool in cirrhotic groups. Previous studies showed the prevalence of malnutrition by SGA to be between 52% and 78%[16-18]. These results were consistent with the results of the current study.

On the other hand, there are a few conflicting results about NRS-2002 assessments in patients with ESLD. Lim et al assessed the nutritional risk prevalence to be 81.8% among patients who were undergoing liver transplantation according to NRS-2002[19]. Another study from Romania showed a 49.8% nutritional risk by NRS-2002 in patients with advanced cirrhosis (CTP group B and C[20]. The current study showed a lower prevalence of nutritional risk according to NRS-2002. When compared to the results of earlier studies, the lower rate of malnutrition according to NRS-2002 could be related to the higher BMI measurements of our patients.

An interesting result of this study is the discrepancy between the malnutrition rates of patients with cirrhosis by NRS-2002 and by SGA. One explanation is that dietary restrictions in patients with cirrhosis (including the protein restriction that was routinely advised in earlier times and now recommended only at the time of hepatic encephalopathy) or salt restriction in subjects who have ascites and edema (which cause impaired oral intake) influence the SGA because the dietary history and gastrointestinal symptoms (e.g., nausea, vomiting, anorexia and diarrhea) are parts of the SGA questionnaire[21, 22].

Although SGA includes objective assessment parameters such as physical examination parameters and weight loss as a percentage or kilogram over the last six months, most of the components of the SGA questionnaire are patient oriented. If the patient has some difficulty in understanding questions or in mild hepatic encephalopathy, SGA assessment might not be reliable, and thus, it would overestimate the malnutrition[23]. Second, our patients with cirrhosis consisted of obese subjects with a mean BMI of 30.1±6.7. Moreover, while the volume overload, including ascites, sacral edema and pedal edema, negatively affects SGA, fluid retention appears to have a positive impact on NRS-2002 in terms of weight gain. As mentioned earlier, dry BMI might be used instead BMI for avoiding from volume overload bias in the assessment of cirrhotic subjects by NRS-2002.

Another interesting result of the current study is the significant correlation of anthropometric measurements, including BMI, dry BMI, hip circumference, MAC, MAMC, MAMA, TST and BC analysis measurements, such as body fat ratio and TBW with NRS-2002 but not SGA. The correlation of parameters that reflect body fat stores (TST, body fat ratio and hip circumference in women) and muscle mass (MAC, MAMC, MAMA and muscle mass) with NRS-2002 has suggested that it is a useful tool to predict the depletion of fat stores and muscle mass. Triceps skinfold thickness is an indirect measurement of the subcutaneous fat stores and is one of the most widely used parameters in the evaluation of the nutritional status in cirrhosis[1, 14, 17, 24]. We showed that TST was lower in patients with cirrhosis than in non-cirrhotic subjects who had similar weight and BMI. This finding suggests that patients with cirrhosis, even if they are obese or normal weight, have reduced lipid deposits. The correlation of the hip circumference with NRS-2002 indicates that the hip circumference might be another indicator of subcutaneous fat stores besides the triceps skinfold. Females have significantly thicker subcutaneous fat than males at the gluteal area[25]. This gender difference should be accounted for if the hip circumference were to be used as a tool for nutritional assessment. Despite conflicting results, several muscle mass parameters, including MAC, MAMC, MAMA and muscle mass, have also been studied in the assessment of patients with cirrhosis for the estimation of the muscle depletion ratio and protein catabolism, indirectly[13, 17, 26]. One of the notable results of the present study is that there were lower values of MAC and hand grip strength in patients with cirrhosis compared to control subjects. The other notable result is the higher correlation rate of MAC with malnutrition according to NRS-2002 compared with the correlations of MAMC and MAMA, while there was no correlation between the hand grip strength measurements and malnutrition among the patients with cirrhosis. This finding could occur because of that MAC is the sum of the muscle mass and subcutaneous fat mass; however, it is an indirect indicator of both muscle mass and subcutaneous fat.

In contrast, MAMC and MAMA are measurements of the muscle mass only. Functional assessment of muscle with hand grip strength measurements could not reflect the nutrition status of cirrhotic subjects in both sexes. However, MAC is a more accurate tool for the assessment of body energy stores in the upper limb.

Our study has several limitations. First, there is a small number of patients, especially women. This prospective study is a single center study, and most of the patients with cirrhosis attended our clinic, and except for those who were excluded, were recruited. Larger studies are needed with a large number of patients with cirrhosis, to investigate the impact of NRS-2002 as a useful tool for the assessment of malnutrition in patients with cirrhosis. Additionally, the gender specific differences could not be assessed due to the small number of patients. The cut-off values of the measurements should be determined separately for men and women in a large series of cirrhotic subjects. Finally, the cross-sectional design of the study could not allow future directions such as the impact of NRS-2002 and SGA on the development of cirrhosis-related complications and survival. However, this issue can be addressed in future studies.

Consequently, the results of the present study indicate that besides nutritional assessment tools, only a few anthropometric measurements and BC analysis parameters differentiate cirrhotic subjects from non-cirrhotic ones. NRS-2002 but not SGA demonstrates correlation with the mentioned anthropometric and BIA measurements in cirrhotic subjects. However, although there is a risk of underestimating the malnutrition due to the volume overload related weight gain, NRS-2002, which is a nonspecific test developed for the nutritional status of inpatients, should be considered to be a useful tool in the nutritional assessment of patients with cirrhosis.

References

1) Figueiredo FA, Perez RM, Freitas MM, Kondo M. Comparison of three methods of nutritional assessment in liver cirrhosis: subjective global assessment, traditional nutritional parameters, and body composition analysis. J Gastroenterol 2006; 41: 476-82.
2) Cheung K, Lee SS, Raman M. Prevalence and mechanisms of malnutrition in patients with advanced liver disease, and nutrition management strategies. Clin Gastroenterol Hepatol 2012; 10: 117-25.
3) Eghtesad S, Poustchi H, Malekzadeh R. Malnutrition in liver cirrhosis:the influence of protein and sodium. Middle East J Dig Dis 2013; 5: 65-75.
4) Tsiaousi ET, Hatzitolios AI, Trygonis SK, Savopoulos CG. Malnutrition in end stage liver disease: recommendations and nutritional support. J Gastroenterol Hepatol 2008; 23: 527-33.
5) Tandon P, Raman M, Mourtzakis M, Merli M. A practical approach to nutritional screening and assessment in cirrhosis. Hepatology 2017; 65: 1044-57.
6) Merli M, Riggio O, Dally L. Does malnutrition affect survival in cirrhosis? PINC (Policentrica Italiana Nutrizione Cirrosi). Hepatology 1996; 2 3: 1041-6.
7) Huynh DK, Selvanderan SP, Harley HA, Holloway RH, Nguyen NQ. Nutritional care in hospitalized patients with chronic liver disease. World J Gastroenterol 2015; 21: 12835-42.

8) Gunsar F, Raimondo ML, Jones S, Terreni N, Wong C, et al. Nutritional status and prognosis in cirrhotic patients. Aliment Pharmacol Ther 2006; 24: 563-72.
9) Frisancho AR. New norms of upper limb fat and muscle areas for assessment of nutritional status. Am J Clin Nutr 1981; 34: 2540-5.
10) Tandon P, Ney M, Irwin I, Ma MM, Gramlich L, et al. Severe muscle depletion in patients on the liver transplant wait list: its prevalence and independent prognostic value. Liver Transpl 2012; 18: 1209-16.
11) Detsky AS, McLaughlin JR, Baker JP, Johnston N, Whittaker S, et al. What is subjective global assessment of nutritional status? JPEN J Parenter Enteral Nutr 1987; 11: 8-13.
12) Kondrup J, Allison SP, Elia M, Vellas B, Plauth M, et al. ESPEN guidelines for nutrition screening 2002. Clin Nutr 2003; 22 :415-21.
13) Rojas-Loureiro G, Servin-Caamano A, Perez-Reyes E, Servin-Abad L, Higuera-de la Tijera F. Malnutrition negatively impacts the quality of life of patients with cirrhosis: An observational study. World J Hepatol 2017; 9: 263-9.
14 Roongpisuthipong C, Sobhonslidsuk A, Nantiruj K, Songchitsomboon S. Nutritional assessment in various stages of liver cirrhosis. Nutrition 2001; 17: 761-5.
15) Campillo B, Richardet JP, Scherman E, Bories PN. Evaluation of nutritional practice in hospitalized cirrhotic patients: results of a prospective study. Nutrition 2003; 19: 515-21.
16) Vieira PM, De-Souza DA, Oliveira LC. Nutritional assessment in hepatic cirrhosis; clinical, anthropometric, biochemical and hematological parameters. Nutr Hosp 2013;28:1615-21.
17) Merli M, Giusto M, Gentili F, Novelli G, Ferretti G, et al. Nutritional status: its influence on the outcome of patients undergoing liver transplantation. Liver Int 2010; 30: 208-14.
18) Marr KJ, Shaheen AA, Lam L, Stapleton M, Burak K, et al. Nutritional status and the performance of multiple bedside tools for nutrition assessment among patients waiting for liver transplantation: A Canadian experience. Clin Nutr ESPEN 2017; 17: 68-74.
19) Lim HS, Kim HC, Park YH, Kim SK. Evaluation of Malnutrition Risk after Liver Transplantation Using the Nutritional Screening Tools. Clin Nutr Res 2015; 4: 242-9.
20) Gheorghe C, Pascu O, Iacob R, Vadan R, Iacob S, et al. Nutritional risk screening and prevalence of malnutrition on admission to gastroenterology departments: a multicentric study. Chirurgia (Bucur) 2013; 108: 535-41.
21) Verslype C, Cassiman D. Cirrhosis and malnutrition: assessment and management. Acta Gastroenterol Belg 2010; 73: 510-3.
22) Les I, Doval E, Garcia-Martinez R, Planas M, Cardenas G, et al. Effects of branched-chain amino acids supplementation in patients with cirrhosis and a previous episode of hepatic encephalopathy: a randomized study. Am J Gastroenterol 2011; 106: 1081-8.
23) Taniguchi E, Kawaguchi T, Itou M, Oriishi T, Ibi R, et al. Subjective global assessment is not sufficient to screen patients with defective hepatic metabolism. Nutrition 2011;27: 282-6.
24) Peng S, Plank LD, McCall JL, Gillanders LK, McIlroy K, et al. Body composition, muscle function, and energy expenditure in patients with liver cirrhosis: a comprehensive study. Am J Clin Nutr 2007; 85: 1257-66.
25) Larkin TA, Ashcroft E, Elgellaie A, Hickey BA. Ventrogluteal versus dorsogluteal site selection: A cross-sectional study of muscle and subcutaneous fat thicknesses and an algorithm incorporating demographic and anthropometric data to predict injection outcome. Int J Nurs Stud 2017; 71:1-7.
26) Alberino F, Gatta A, Amodio P, Merkel C, Di Pascoli L, et al. Nutrition and survival in patients with liver cirrhosis. Nutrition 2001; 17: 445-50.

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