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Comparison of Nutritional Risk Index with Subjective Global Assessment in Evaluating the Nutritional Status of Liver Transplant Candidates

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ABSTRACT

Introduction: We launched this study to compare subjective global assessment (SGA) and nutrition risk index (NRI) as malnutrition screening tools for nurses to use in the care of End-stage Liver Disease (ESLD) patients.

Methods: This pilot study was conducted on liver transplant patients in two hospitals in Iran from May to September 2021. Sensitivity, specificity, and predictive values of NRI were evaluated compared with SGA in ESLD patients.

Results: Sixty-five cirrhotic patients were assessed. The sensitivity, specificity, positive and negative predictive values for NRI in detecting malnutrition based on SGA were 97.67%, 31.82%, 77.68%, and 87.5%, respectively. However, the agreement between NRI and SGA was low (k=0.349). Changing the NRI cut-off value to 83.7 could yield acceptable sensitivity (72.7%) and specificity (58.1%).

Conclusion: NRI can be used as a screening tool in ESLD patients, but a different cut-off might be required to improve its validity against SGA in ESLD patients.

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Introduction

Cirrhosis is widely prevalent worldwide and can result from various causes, such as non-alcoholic fatty liver disease (NAFLD), obesity, hepatitis B or C infection, autoimmune diseases, excessive alcohol consumption, cholestatic diseases, and copper or iron overload(1). Liver cirrhosis develops after replacing the healthy liver parenchyma with fibrotic tissue and regenerative nodules due to a long period of inflammation(2). Malnutrition is a frequent but often neglected complication in patients with cirrhosis, and it is a significant prognostic factor for morbidity and mortality (3, 4). The reported prevalence of malnutrition in cirrhosis varies from 23–60% (5, 6). This malnutrition is associated with the degree of hepatic dysfunction and increased morbidity before and after liver transplantation (7, 8). So, it is crucial to evaluate the nutritional status of cirrhotic patients before liver transplantation. Significant variability in the prevalence of malnutrition has been observed, depending on the method used for assessment and the severity of the disease, which can change the body composition and analytical parameters(8). Therefore, there is no consensus among authors on the most effective methods to assess the nutritional state of these patients. Also, Studies have consistently revealed the inadequacy of any single assessment method or tool to evaluate the nutrition status of patients.

The European Society for Clinical Nutrition recommends evaluating malnutrition in patients with liver cirrhosis through tests, including

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subjective global assessment, anthropometry, biomedical impedance, and hand-grip strength evaluation(9). Some authors have tried to identify the best tools for evaluating the nutritional status of these patients, considering the recommendations and variety of methods. Subjective global assessment (SGA) is a non-invasive, easy-to-apply, low-cost, validated method to assess malnutrition in patients with cirrhosis (10). It has been widely advocated because it relies on patient history and physical examination, overcoming the drawback of interpreting objective parameters affected by liver disease(11). The nutritional risk index (NRI) is a scale widely used in recent years, which allows us to evaluate nutritional risk in a simplified manner using two basic parameters: weight and albumin(12). Its usefulness has been demonstrated to predict the risk of mortality, survival, and postoperative complications in different scenarios, such as liver transplantation (13).

In this study, we aimed to compare NRI and SGA in liver transplant candidates and to determine the sensitivity, specificity, and predictive values of NRI compared to SGA as a nutritional screening tool in cirrhotic patients who are candidates for liver transplantation.

Methods

We conducted a pilot study in Montaseriyeh Hospital, Mashhad, Iran, and Firoozgar Hospital, Tehran, Iran. During the study period (from May to October 2021), Patients over 18 years who were on the waiting list for liver transplant and signed the informed consent were included in the study based on the convenience sampling method. Exclusion criteria were refusal to participate in the study. The patients were identified with a code in order to keep their data confidential. Clinical records were reviewed to obtain the necessary information for the study, a physical examination was performed, and the patients were interviewed. The anthropometric indices, including height and weight, were measured, and body mass index (BMI) was calculated for all patients. The degree of liver dysfunction was evaluated using the model for end-stage liver disease (MELD) and Child-Pugh Score, in which a higher score indicates greater liver dysfunction. The assessment of nutritional status was performed using SGA and NRI scales. The sample size was estimated based on the area under curve (AUC). We considered a null hypothesis (H0) of AUC=0.6 and an H1 of AUC=0.8. Considering an alpha error of 5%, power of 80%, and a ratio of 0.5 for sample size in negative/positive groups, the estimated sample size was 38 positive cases and 19 negative cases (overall 57 patients). Considering a 10% dropout, the required sample size was increased to 43 positive cases and 22 negative cases (overall 65 patients). The research protocol was approved by the School of Medicine, Mashhad University of Medical Sciences, Biomedical Research Ethics Committee. (IR.MUMS.MEDICAL.REC.1399.815) A trained investigator performed all measurements to reduce errors.

Nutritional Status Assessment

The nutritional status of the patients was assessed based on SGA, NRI, anthropometric measurements, and biochemical tests.

Subjective Global Assessment

SGA includes nutritional data regarding current weight, weight before illness, and weight change in the past 15 days, as well as one and six months; nutritional history (appetite, diet intake, gastrointestinal symptoms), gastrointestinal problems (diarrhea, vomiting, nausea), functional physical capacity and physical assessment (signs and symptoms of fat loss, edema, muscle wasting, and ascites) (11). Patients were classified as well-nourished (SGA-A), moderately malnourished (SGA-B), or severely malnourished (SGA-C) based on the categorical assessment provided by the SGA tool. SGA has been used as the gold standard for nutrition assessment in various studies of patients with cirrhosis; therefore, it was considered as the gold standard for detecting malnutrition in our study(14).

Nutrition Risk Index

NRI was calculated based on the following equation:

$$NRI = 1.519 \times \text{serum albumin (g/L)} + 41.7 \times (\text{present weight/usual weight})$$

Patients with NRI scores greater than 100 were considered as no-risk, patients with NRI between 97.5 and 100 were considered to be at mild nutrition risk, patients with NRI scores between 83.5 and 97.5 were considered to be at moderate nutrition risk, and patients with NRI below 83.5 were considered to be at severe nutrition risk. The usual body weight was defined as the patient's stable weight for the last six months based on medical records or previous measurements.

Anthropometric Measurements

The weight and height of patients were measured by a stadiometer. Patients' weight was measured in a standard position with minimal clothes and no shoes using a scale to the nearest 100 grams and deducing one kilogram of weight due to patient clothes. Height was measured while standing with the head in the Frankfurt plane. BMI was calculated as body weight(kg)/height (m^2). Patients with a BMI <18.5 kg/m^2 were considered underweight, BMI 18.5 to 24.9 kg/m^2 normal weight, BMI 25 to 29.9 kg/m^2 overweight, and BMI ≥ 30 kg/m^2 obese(15). To overcome the effect of ascites on BMI, 5% of the weight was reduced in the case of mild to moderate ascites, and 15% of the weight was reduced in the case of refractory ascites(16).

Biochemical Tests

Fasting venous blood samples were obtained from all patients for biochemical assessment. Biochemical markers include Albumin, Total Protein, Blood Urea Nitrogen (BUN), Creatinine, Bilirubin, International normalized ratio (INR) and Prothrombin Time (PT), Potassium, Sodium, Liver enzymes including Alanine Aminotransferase (ALT), Aspartate Aminotransferase (AST), and Alkaline Phosphatase (ALP) were measured using BT3500 autoanalyzer and Pars Azmoun Biochemistry Kit.

Statistical Analysis

Data were collected and statistically analyzed using SPSS software version 16.0. Data are expressed as mean ± standard deviation. The chi-square test was used to compare the proportion between the two groups. A contingency table was used to determine the sensitivity, specificity, predictive values, and accuracy of NRI as a malnutrition screening tool compared to SGA as the gold standard. The Kolmogorov-Smirnov test was used to check the normality distribution of quantitative variables. Pearson correlation analysis was performed to evaluate the agreement between scores. Agreement in classification was studied using the statistical Kappa (K) index. The receiver operating characteristics (ROC) curve was used to evaluate the diagnostic accuracy (area under the curve, AUC) and the cut-off for NRI in detecting malnutrition. All tests were two-sided, and the statistical significance level was considered 0.05 for all tests.

Table 1. Baseline characteristics of the candidate patients for liver transplantation

Characteristics	Group, n = 65
Weight (kg)	67.92±15.26
BMI (kg/m^2)	24.20±4.92
Total protein (g/dl)	6.51±1.07
Albumin (g/dl)	2.99±0.70
Creatinine (mg/dl)	1.16±0.54
BUN (mg/dl)	24.60±15.86
T.Bili (mg/dl)	3.83 (2.29-7.30)
D.Bili (mg/dl)	2.01 (1.22-5.40)
PT	17.08±5.09
INR	1.40 (1.10-1.78)
AST (UL/l)	57.00 (35.00-92.00)
ALT (UL/l)	38 (26.00-63.00)
ALP (UL/l)	359.00 (225.00-591.00)
Sodium (mEq/L)	137 (135.00-140.00)
Potassium (mEq/L)	4.10 (3.80-4.40)
Child-Pugh stage	
A	10 (15.39%)
B	29 (44.61%)
C	26 (40.00%)
Etiology	
Cryptogenic	12 (20.00%)
HBV/HCV	17 (28.33%)
PSC/PBC	9 (15.00%)
AIH	7 (11.67%)
Other	15 (25.00%)

BMI, Body Mass Index; BUN, Blood urea nitrogen; T.Bili, Total Bilirubin; D.Bili, Direct Bilirubin; PT, Prothrombin time; INR, International normalized ratio; AST, Aspartate Aminotransferase; ALT, Alanine Aminotransferase; ALP, Alkaline Phosphatase; HBV, Hepatitis B virus; HCV, Hepatitis C virus; PSC, Primary Sclerosing Cholangitis; PBC, Primary Biliary Cirrhosis; AIH, Autoimmune Hepatitis.

Results

This study included 65 patients with a mean age of 47.32±14.05 years and a mean MELD score of 16.8 ±5.46. Our patients were predominantly male (60.00%). According to BMI classification, 11.6% of our patients were underweight, 46.51% were normal weight, and 41.86% were overweight or obese. In five patients, the underlying etiology was not recorded. Among the patients with documented etiology, the most common underlying disease that eventually led to liver transplantation was cryptogenic (12 patients, 20.00%). The baseline characteristics of the patients are shown in Table 1.

Table 2. Prevalence of malnutrition based on SGA and NRI

	Normal nutritional status (%)	Moderate Malnutrition (%)	Severe Malnutrition (%)	P-Value
SGA	22 (33.85)	20 (30.77)	23 (35.38)	0.008
NRI	8 (12.31)	26 (40.00)	31 (47.69)	

SGA, Subjective Global Assessment; NRI, Nutritional Risk Index

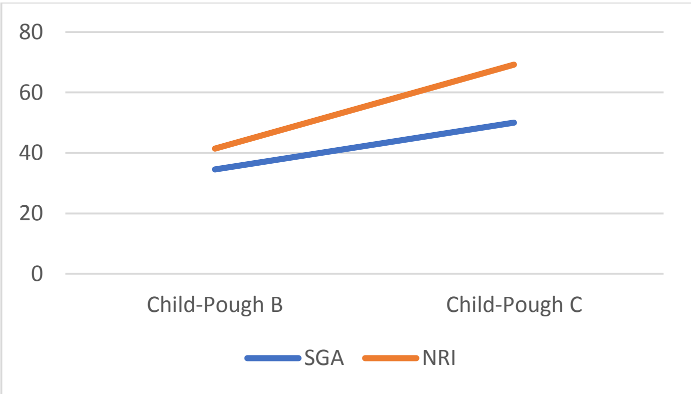

Figure 1. Distribution of severe malnutrition prevalence according to the degree of hepatic dysfunction (Child-Pugh).

The prevalence of malnutrition based on SGA and NRI is shown in Table 2. According to SGA classification, 22/65 (33.85%) were in category A (well-nourished), 20/65 (30.77%) were in category B (moderate malnutrition), and 23/65 (35.38%) were in category C (severe malnutrition). Also, 8/65 (12.31%) were placed in the No risk group, 26/65 (40.00%) were in the moderate risk group, and 31/65 (47.69%) were in the severe risk group based on NRI. Examining the prevalence of severe malnutrition according to the Child-Pugh classification, we found that the higher the hepatic dysfunction, the worse the nutritional state ($p < 0.001$) (Figure 1). None of the patients in the Child-Pugh A group had severe malnutrition.

Table 3. Validity of NRI as a screening tool for malnutrition in ESLD patients as compared to SGA

characteristics	SGA (malnourished)	SGA (normal)
NRI (malnourished)	42 (true positive)	15 (false positive)
NRI (normal)	1 (false negative)	7 (true negative)

SGA, Subjective Global Assessment; NRI, Nutritional Risk Index

The ability of NRI to predict nutrition status is shown in Table 3. Based on the data presented in Table 3, the sensitivity and specificity of NRI in detecting malnutrition were 97.67% and 31.82%, respectively, against SGA. The positive and negative predictive values of NRI were 77.68% and 87.50%, respectively, against SGA. The accuracy of the test was 75.39%. SGA was positively correlated with NRI ($r = -0.334$, $P = 0.007$). The ROC curve was generated for NRI in our patient population using SGA as the gold standard (Figure 2).

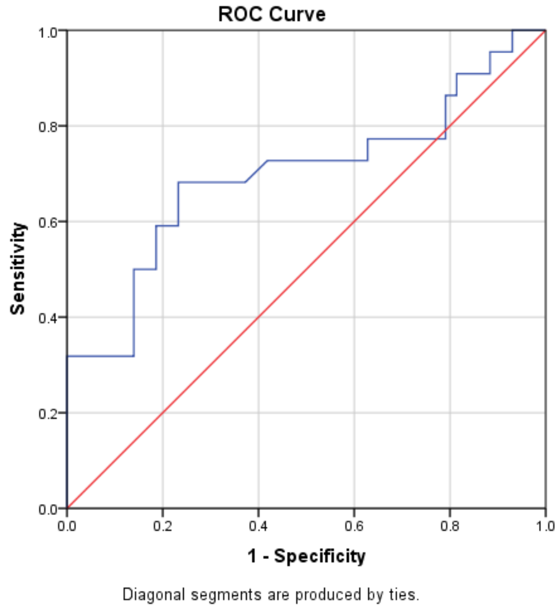

Figure 2. The receiver operating characteristics (ROC) curve of nutrition risk index (NRI) compared to subjective global assessment (SGA) (Area under the curve=0.699, 95% CI: 0.549-0.848, p=0.009)

Considering the difference in the prevalence of malnutrition depending on the method used, we calculated the level of agreement between the two scales. Pairwise agreement between methods was low (K = 0.349). The prevalence of malnutrition based on SGA and NRI and the level of agreement between methods are shown in Table 4.

Table 4. Prevalence of malnutrition and level of agreement between methods

Prevalence of malnutrition	SGA	NRI
	66.15%	87.69%
Kappa Index among methods		
Methods	**SGA**	**NRI**
SGA	1	0.349
Agreement		P = 0.001

SGA, Subjective Global Assessment; NRI, Nutritional Risk Index

The ROC analysis revealed that the AUC for NRI in predicting malnutrition based on SGA was 0.699 (95% CI: 0.549-0.848). NRI at the cut-off of 83.70 could predict malnutrition with 72.70% sensitivity and 58.1% specificity (Figure 2).

Discussion

Different evaluation methods, including anthropometric parameters, such as BMI, are used to identify the risk of malnutrition in ESLD patients. According to the BMI classification, 11.6% of our patients were underweight, and 41.86% were overweight or obese. This result may be due to the presence of ascites in most patients, which may have confounded the body composition. This finding was similar to other publications, which conclude that BMI underestimates malnutrition and is not a suitable method to evaluate nutritional status in ESLD patients. In the study by Villalobos et al., 5% of hospitalized patients were classified with possible malnutrition according to BMI, which was very low compared to other evaluation methods (17). In conclusion, the assessment of the nutritional status of cirrhotic patients by BMI may not be a reliable method because it can be influenced by water retention. Therefore, it was not included as a nutritional status assessment method in our study.

Subjective global assessment

SGA has been used as the gold standard for nutrition assessment in various other studies for patients with cirrhosis; therefore, we also used SGA as the gold standard in our study(14). Our study showed that according to the SGA questionnaire, the prevalence of malnutrition in patients before liver transplantation was 66.15%, and the prevalence of severe malnutrition was 35.38%. The observed prevalence of malnutrition in our study was similar to most previous studies (18-21). For instance, in Yadav's study, the prevalence of malnutrition using SGA was 86.3%, and the prevalence of severe malnutrition was 35%.(21).

Nutritional Risk Index

Regarding the validity of NRI as a nutrition status screening tool, we observed that using the conventional cut-off for NRI yielded a high sensitivity but low specificity compared to SGA as the gold standard. NRI has been used to define nutritional risk in some recent studies where the effects of undernutrition or nutritional intervention were investigated(22, 23). NRI relies on serum albumin concentration and percentage of usual weight. The formulae-based calculation of NRI provides some objectivity in assessing nutrition status. NRI formula also contains serum albumin level, which is considered an important biochemical parameter to determine the nutrition status of ESLD patients. The prevalence of malnutrition based on NRI was higher (87.69%) than SGA (66.15%) in our study. This can be explained by the pathology of the patients, which may have affected serum albumin concentration. The association between the degree of liver dysfunction and malnutrition was in line with the findings of a previous publication(24).

Concordance of nutritional methods

Our study showed that the agreement between SGA and NRI was low (K = 0.349). This finding was similar to the findings of the study by García-Rodríguez et al. on liver transplant candidates (k=0.041) (24). Similarly, a study on colorectal cancer patients showed that the agreement between NRI and SGA was low (k=0.21) (25). Similarly, Faramarzi et al. evaluated the validity of NRI compared to PG-SGA in colorectal cancer patients and observed that the two scales did not have a statistically significant agreement (k =0.267; P>0.05) (26). There was also a low agreement between SGA and NRI among hospitalized adults (k = 0.24) (27). In contrast to the findings of our study, in a study conducted by Sungurtekin et al.(28) on patients hospitalized in the surgical ward, a good agreement was observed between SGA and NRI (k = 0.57). This finding may be related to the difference in the inclusion criteria because we included patients with liver cirrhosis who had a chronic disease.

Diagnostic validity of the NRI in comparison with the SGA

Although reference bias cannot be ruled out, the results of our study could be helpful in identifying suitable methods of assessing malnutrition in ESLD patients. Using the SGA as the reference method; the NRI showed a high diagnostic validity for malnutrition according to the ROC curve. A cut-off of 83.7 for NRI improved the specificity of the scale compared to the conventional cut-off in our study. In a study by Deniz et al.(29), The optimal cut-off value for NRI to predict malnutrition in hemodialysis patients was 86.0 (64.9% sensitivity and 62.8% specificity). Therefore, it can be hypothesized that different NRI cut-offs might be required to predict malnutrition in different diseases. However, more studies are needed to justify this hypothesis.

NRI can be considered a sensitive scale for identifying malnutrition. Assessing specificity is essential in preventing well-nourished patients from being incorrectly identified as malnourished(30). Accurate identification of malnourished ESLD patients and the resultant timely nutritional intervention will improve transplantation outcomes. Our study indicated that a different cut-off for NRI may increase its specificity while having a still acceptable sensitivity in detecting malnutrition in ESLD patients. This finding adds to the findings of previous studies in a previous study that there might be a need to define different cut-offs for NRI in different diseases, especially diseases with water retention. However, more studies should be conducted to reach a definite conclusion in this regard.

Strengths and limitations

The strength of our study was a multicenter study. However, the sample size was a limitation of our study due to the limited data collection time. External validation of our results in other populations is needed. It is also recommended to test the validity of other nutrition status screening tools against SGA in further studies.

Conclusion

Our study found a high prevalence of malnutrition among patients on the waitlist for a liver transplant and variability in the estimated prevalence of malnutrition depending on the evaluation method. The nutritional risk index can be used as a screening tool for the assessment of the nutritional status of ESLD patients with high sensitivity. However, with the current cut-off, NRI cannot be used as a diagnostic tool because of its low specificity. Modification of the NRI cut-off might be required to improve its validity against SGA in ESLD patients.

Conflict of Interest

The authors have no conflict of interest

Authors' Contributions

Study concept and design: H. B., and M. N.; analysis and interpretation of data: M. A. and A. N.; drafting of the manuscript: H. B.; critical revision of the manuscript for important intellectual content: M. N.; statistical analysis: H. B.

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