Nutritional assessment of cirrhotic patients with variable severity

Magda S. Hassan[a], Abeer S. Eldin Abdel Rehim[a], Medhat A. Khalil[b], Yasmin A. Mahmoud Osman[a]

[a]Department of Tropical Medicine and Gastroenterology, [b]Department of Public Health and Community Medicine, Assiut University Hospital, Assiut, Egypt

Correspondence to Yasmin A. Mahmoud Osman, MSC, Apartment 902, 8th Floor, El Aqsa Tower, El Helaly Street, Assiut, Egypt
Tel: +20 109 908 8852;
e-mail: yasmineashraf.7@gmail.com

Received 19 February 2018
Accepted 31 March 2018

Journal of Current Medical Research and Practice
May-August 2019, 4:144–151

Introduction
Malnutrition presents in more than half of cirrhotic patients. It is varied from 20% in compensated liver disease to 80% in decompensated liver disease. This study aimed at assessing the frequency of malnutrition and relation between the malnutrition and degree of liver severity.

Patients and methods
This study was carried out in Tropical Medicine and Gastroenterology Department at El-Rajhy Hospital in Assiut University, Egypt, from December 2015 to December 2016 on 101 patients diagnosed with liver cirrhosis. Based on their medical profile, the liver disease severity was determined by Child–Pugh, model for end-stage liver disease, and model for end-stage liver disease sodium scores, then nutritional status of the patients was assessed by different methods including anthropometric diameters (BMI, triceps skinfold thickness, mid-arm circumference, and mid-arm muscle circumference), body composition analysis, subjective global assessment, creatinine–height index, prognostic nutritional index (PNI), and controlling nutritional status (CONUT), and finally, we assessed the relation between the nutritional status and the severity of liver disease.

Results
The frequency of malnutrition among the studied patients varied from 25.7% by BMI to 98% by PNI and CONUT. There was difference in degree of malnutrition between the different groups of liver disease; however, this variation was not significant when anthropometric measures and body composition analysis were used but was statistically significant when subjective global assessment, creatinine–height index, PNI, and CONUT were used.

Conclusion
The nutritional status of cirrhotic patients is an important tool, together with Child and model for end-stage liver disease scores, for the prediction of prognosis of such patients. All the nutritional assessment tools are needed together with no substitution of one method by another for precise assessment of malnutrition among cirrhotic patients.

Keywords:
anthropometric, creatinine, nutritional assessment, prognostic nutritional, subjective global assessment

J Curr Med Res Pract 4:144–151

2357-0121

Introduction

Malnutrition is a common complication of liver cirrhosis and is an important prognostic indicator of clinical outcome (survival rate, length of hospital stay, posttransplantation morbidity, and quality of life). Several studies have evaluated nutritional status in patients with liver cirrhosis of varying degrees [1], leading to the opinion that malnutrition is recognizable in all forms of cirrhosis [2], and that the causes of malnutrition in liver disease are complex and multifactorial.

Malnutrition is present in more than half of cirrhotic patients. It is varied from 20% in compensated liver disease to more than 80% in those patients with decompensated liver disease [3].

Aim of the work

The aims of the work were as follows:
(1) Identification of the frequency and severity of malnutrition among patients having liver cirrhosis.
(2) Assessment of the relationship between malnutrition, dietary status, and severity of liver disease.

Patients and methods

This study was carried out in Tropical Medicine and Gastroenterology Department at El-Rajhy Hospital in Assiut University, Egypt, from December 2015 to December 2016 on 101 patients who were selected based on the following inclusion and exclusion criteria.

(1) Inclusion criteria:
  (a) Adult inpatients with age range from 18 to 70 years of both sexes
(2) Exclusion criteria:
  (a) Patients with hepatorenal syndrome
  (b) Hepatocellular carcinoma
  (c) Hepatic encephalopathy grades 3–4
  (d) Patients with chronic debilitating disease such as tuberculosis, chronic renal failure, diabetes mellitus, hyperthyroidism, malabsorption syndrome, and inflammatory bowel diseases.

Cirrhosis was diagnosed based on a combination of clinical features such as jaundice, spider naevi, and palmar erythema. Clinical features were those of portal hypertension, that is, ascites and/or gastrointestinal varices. Blood profiles included evidence of thrombocytopenia and/or coagulopathy. Radiological features, either with transabdominal ultrasound or computed tomography, had to demonstrate a coarse/small shrunken liver with or without splenomegaly and intraabdominal varices.

Laboratory investigations include complete blood picture with more consideration on hemoglobin level and total lymphocytic count, kidney function tests, and liver function tests, especially total protein and albumin, serum sodium, and serum cholesterol, and also 24-h urinary creatinine excretion assessments are done using the standard techniques.

Classification of the severity of liver cirrhosis

Child–Pugh score classification is as follows: class A (score 5–6), class B (score 7–9), and class C (score >9) [4].

Model for end-stage liver disease (MELD) score and model for end-stage liver disease sodium (MELD Na) score are used in the classification of severity in liver cirrhosis. MELD score is calculated as follows: 3.78×log [serum bilirubin (mg/dl)]+11.2×log [INR]+9.57×log [serum creatinine (mg/dl)]+6.43 [5,6].

MELD Na score is calculated as MELD + 1.59[135–serum Na (mEq/l)].

Both MELD and MELD Na scores were classified into three groups as follows:

(1) Mild liver disease (score 6–15)
(2) Moderate liver disease (score 16–24)
(3) Sever liver disease (score ≥ 25) [7].

Assessment of the nutritional status of the studied patients:

(1) The anthropometric parameters:
  These included body weight and height. BMI, mid-arm circumference (MAC), triceps skinfold thickness (TSFT), and mid-arm muscle circumference (MAMC), which is calculated from MAC and TSFT using a standard formula:

$$\text{MAMC} = \left[\text{MAC} - \left(3.14 \text{ X TSFT}\right)\right]$$

  TSFT, MAC, and MAMC were recorded according to Frisancho [8] percentile tables, and the nutritional status by the anthropometric parameters was classified to three groups according to Blackburn and Harvey [9] as follows:
  (a) Normal to mild malnutrition above 10th percentile
  (b) Moderate malnutrition 5th–10th percentile
  (c) Severe malnutrition below 5th percentile
  The reference values for malnutrition in patients with cirrhosis by BMI are the following:
  (d) No ascites, BMI 22 kg/m^2
  (e) Mild ascites, BMI 23 kg/m^2
  (f) Tense ascites, BMI 25 kg/m^2 [10].
(2) Body composition analysis:
  It is done for all patients by foot-to-foot whole-body bioelectrical impedance analysis using Beurer diagnostic scale (BF 100 body complete).
  Fat mass percentage was recorded according to Kyle percentile table [11]
  The nutritional status was classified into three groups based on fat mass percent [11]
  (a) Normal to mild malnutrition fat percent above 10th percentile
  (b) Moderate malnutrition fat percent between 5th and 10th percentile
  (c) Severe malnutrition fat percent below 5th percentile
(3) Creatinine–height index (CHI):
  All patients are asked to collect urine for 24 h and then 24 h urinary creatinine is measured and compared with the values expected for the same height, which is adapted by Blackburn *et al.* [12]. Then, the CHI is calculated from the following formula:

$$\text{CHI} = \text{24 - h urine creatinine excretion}(\text{mg}) / \text{expected 24 - h urine creatinine excretion}(\text{mg}) \times 100.$$

  Interpretation of the obtained results is as follows:
  (a) CHI (≥80%): there is normal protein status
  (b) CHI (60–80%): there is a mild protein depletion
  (c) CHI (40–60%): there is moderate protein depletion
  (d) CHI (<40%): there is severe protein depletion [13]
(4) Prognostic nutritional index (PNI):
  The PNI is calculated as follows: PNI = albumin × 10 + TLC × 0.005

Nutritional status assessed by the PNI was classified into four degrees of severity as follows:
  (a) PNI of 50 or more signifies no malnutrition
  (b) PNI of 40–49 signifies mild malnutrition.
  (c) PNI of 30–39 signifies moderate malnutrition
  (d) PNI of less than 30 signifies severe malnutrition

(5) Controlling nutritional status (CONUT):
Nutritional status assessed by CONUT was classified according to the total score into four degrees of severity: no malnutrition: score 0–1, mild malnutrition: score 2–4, moderate malnutrition: score 5–8, and severe malnutrition: score 9–12

(6) Subjective global assessment (SGA):
The standard SGA comprised a nutritionist's evaluation of height, weight (current, before illness, and weight range in the previous 6 months), nutritional history (appetite, intake, gastrointestinal symptoms), and physical appearance (subjective assessment of fat loss, muscle wasting, edema, and ascites), and then nutritional status is classified into three categories: class A, no malnutrition; class B, mild to moderate malnutrition; and class C, severe malnutrition.

Ethical consideration

Informed consent was obtained from all participants; it was explained to all the participants that the collected data will be confidential and used for the purpose of scientific research only. All investigations were free, without any financial burden on the participants. Furthermore, any faulty dietary habits were advised through health education.

Statistical analysis

Date entry and data analysis were done using Statistical Package for Social Science, version 19 (statistical analysis was done in public heath Department, Assiut university hospital, Egypt). Data were presented as number, percentage, mean, and SD. χ^2 test was used to compare between qualitative variables. Mann–Whitney test was used to compare quantitative variables between two groups as nonparametric data. Spearman's correlation was done to measure correlation between quantitative variables. *P* value was considered statistically significant when *P* value less than 0.05.

Results

The etiology and the severity of liver cirrhosis among the studied population

The most common etiology of cirrhosis in our study was viral hepatitis, where HCV is the most frequently prevalent among the studied population (94.1%).

The studied patients were classified based on the frequently used prognostic scores: Child, MELD, and MELD Na, where most of the patients were Child B (52.5%) followed by Child C (25.7%) and then Child A (21.8%), and 63.4% of the patients had mild liver disease (MELD and MELD Na scores 6–15).

The prevalence of malnutrition in the studied patients using anthropometric measures

Malnutrition was demonstrated among the studied patients by different anthropometric parameters such as BMI, TSF, MAC, and MAMC, where BMI described malnutrition in 25.7% of our patients, whereas TSFT showed moderate and severe malnutrition to be present in 21.8 and 25.7%, respectively. Moreover, malnutrition was found in 75.2% and in 67.3% of the participants when assessed by MAC and MAMC, respectively.

There was no statistical significant difference in the anthropometric parameters between groups of Child score except in MAC between Child A and B and between Child A and C and in MAMC between Child A and B (Table 1).

The prevalence of malnutrition in the studied patients using body composition analysis

Overall, 22.8% of the studied patients had very low fat mass, whereas 13.9% had high water content, but there was no statistically significant difference in body composition analysis between groups of Child scores, except in water percentage between Child A and B and between Child A and C (Table 2).

The prevalence of malnutrition in the studied patients using subjective global assessment

Overall, 64.4% of the studied patients were malnourished by SGA, and class A of SGA was more prevalent in Child A; however, class B and C were more in Child C, with significant difference between Child A and B, and Child A and C. However, there was no significant variation in SGA classes between groups of MELD and MELD Na scores (Table 3).

The prevalence of malnutrition in the studied patients using the creatinine–height index

Based on CHI, protein energy malnutrition (PEM) was detected in 94.1%, as 47.5 and 38.6% of patients had mild and moderate protein depletion, respectively. However, severe protein depletion was found in 7.9%. The mean value of CHI significantly decreased as the

Table 1 Nutritional assessment based on anthropometric parameters in Child-Pugh groups

	Child score (mean±SD)			P^a	P^b	P^c
	Child A (*n*=22)	Child B (*n*=53)	Child C (*n*=26)			
BMI	26.90±6.72	26.50±5.75	27.23±4.73	0.898	0.495	0.348
TSFT	14.59±5.01	13.51±5.15	12.08±5.50	0.421	0.069	0.219
MAC	26.89±3.91	24.50±4.13	24.58±4.23	0.012*	0.030*	0.862
MAMC	22.30±3.62	20.23±3.57	20.64±3.68	0.013*	0.061	0.818

MAC, mid-arm circumference; MAMC, mid-arm muscle circumference; TSFT, triceps skinfold thickness. ^{a}*P* value between Child A and B, ^{b}*P* value between Child A and C, and ^{c}*P* value between Child B and C. **P*-value considered statistically significant when $P < 0.05$. There is statistical significance in MAC between child A and B and between child A and C and also significant difference in MAMC between child A and B.

Table 2 Body composition analysis across Child-Pugh score

	Child score (mean±SD)			P^a	P^b	P^c
	Child A (*n*=22)	Child B (*n*=53)	Child C (*n*=26)			
Fat %	24.04±6.17	21.11±6.64	21.58±5.24	0.103	0.296	0.661
Muscle %	36.51±3.25	38.63±6.62	38.16±7.87	0.240	0.836	0.562
Water %	50.61±5.06	54.98±8.59	56.25±9.42	0.037*	0.048*	0.555
Weight of bone (kg)	10.09±1.37	9.86±1.18	10.25±0.99	0.478	0.604	0.105

^{a}*P* value between Child A and B, ^{b}*P* value between Child A and C, and ^{c}*P* value between Child B and C. **P*-value considered statistically significant when $P < 0.05$. There is statistical difference in the body water percent between child A and B and between child A and C.

Table 3 Nutritional assessment by subjective global assessment classes in Child-Pugh groups

SGA	Child score [*n* (%)]			P^a	P^b	P^c
	Child A	Child B	Child C			
Class A	15 (68.2)	14 (26.4)	7 (26.9)			
Class B	7 (31.8)	32 (60.4)	11 (42.3)	0.002*	0.003*	0.144
Class C	0 (0.0)	7 (13.2)	8 (30.8)			

SGA, subjective global assessment. ^{a}*P* value between Child A and B, ^{b}*P* value between Child A and C, and ^{c}*P* value between Child B and C. **P*-value considered statistically significant when $P < 0.05$. there is statistical difference in the SAG water percent between child A and B and between child A and C.

liver cirrhosis progressed from Child A to C and from lower score to the higher score of MELD and MELD Na (Tables 4–7, Figs. 1 and 2).

The prevalence of malnutrition in the studied patient using prognostic nutritional index and controlling nutritional status

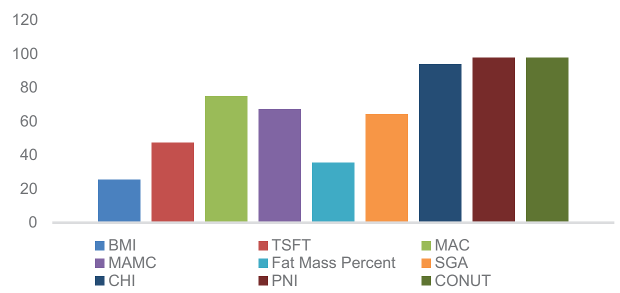
According to PNI and CONUT, malnutrition was found in 98% of our patients, where most of the patients (54.9%) had severe malnutrition based on CONUT.

The mean values of PNI significantly decreased from Child A to C and from lower to higher scores of MELD and MELD Na; however, CONUT is significantly lower in Child A and in mild liver disease but similar in Child B and C and in moderate and severe liver diseases.

The diagnostic accuracy of the subjective methods versus the objective measures

In our study, we used the receiver operating characteristic curve at different areas under the curve (0.635, 0.654, 0.646, and 0.681), and the diagnostic accuracy of the SGA was low in comparison with other objective parameters (TST, MAC, CHI, and PNI), where the accuracy was varied from 64.4 to 76% (Fig. 3a–d).

Figure 1



Prevalence of malnutrition in the studied patients according to different nutritional assessment tools. CHI, creatinine–height index; CONUT, controlling nutritional status; MAC, mid-arm circumference; MAMC, mid-arm muscle circumference; PNI, prognostic nutritional index; SGA, subjective global assessment; TSFT, triceps skinfold thickness.

Discussion

There are few data concerning the nutritional assessment in liver cirrhosis in our population; however, this is an important issue to be lighted upon to determine risky patients who are liable for development of malnutrition and hence the occurrence of decompensation, complications, and mortality.

Regarding the nutritional assessment by anthropometric parameters by the BMI, 25.7% of the patients were malnourished. These values were higher than those found in Vieira *et al.* [14] which reported that 16.7% of the studied patients had malnutrition. When comparing BMI among Child–Pugh groups, normal

Table 4 The mean value of creatinine-height index in Child-Pugh groups

	Child score (mean±SD)			P^a	P^b	P^c
	Child A (*n*=22)	Child B (*n*=53)	Child C (*n*=26)			
CHI	71.63±8.33	61.27±10.31	49.18±10.48	0.000*	0.000*	0.000*

CHI, creatinine-height index. ^{a}*P* value between Child A and B, ^{b}*P* value between Child A and C, and ^{c}*P* value between Child B and C. **P*-value considered statistically significant when $P < 0.05$. there is statistical difference in the CHI between all stages of liver disease child A and B and C.

Table 5 Nutritional assessment by prognostic nutritional index and controlling nutritional status in Child-Pugh groups

	Child score (mean±SD)			P^a	P^b	P^c
	Child A (*n*=22)	Child B (*n*=53)	Child C (*n*=26)			
PNI	37.18±8.84	29.16±5.28	26.85±4.83	0.000*	0.000*	0.014*
CONUT	7.14±2.73	9.32±1.87	9.63±1.71	0.000*	0.000*	0.278

CONUT, controlling nutritional status; PNI, prognostic nutritional index. ^{a}*P* value between Child A and B, ^{b}*P* value between Child A and C, and ^{c}*P* value between Child B and C. **P*-value considered statistically significant when $P < 0.05$. there is statistical difference in the PNI between all stages of liver disease child A and B and C and also statistical significance in CONUT between child A and B and between child A and C.

Table 6 Nutritional assessment by prognostic nutritional index and controlling nutritional status among model for end-stage liver disease groups

	MELD (mean±SD)			P^a	P^b	P^c
	Mild liver disease (*n*=64)	Moderate liver disease (*n*=29)	Severe liver disease (*n*=8)			
PNI	31.16±6.59	26.41±3.77	28.16±7.58	0.000*	0.015*	0.726
CONUT	8.71±2.24	9.82±1.55	9.33±2.16	0.002*	0.164	0.775

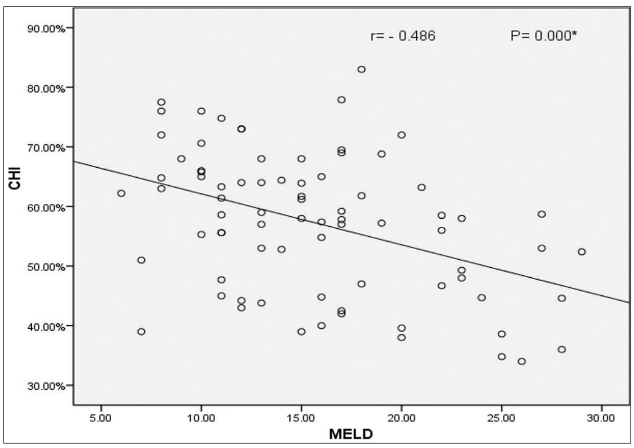
CONUT, controlling nutritional status; MELD, model for end-stage liver disease; PNI, prognostic nutritional index. ^{a}*P* value between Child mild and moderate liver disease, ^{b}*P* value between Child mild and severe liver disease, and ^{c}*P* value between Child moderate and severe liver disease. *P*-value considered statistically significant when $P < 0.05$. There is statistical difference in the PNI between mild and moderate liver stage and between mild and sever liver stage when assessed by MELD score. While regarding the CONUT, the significant difference in the mean value was between mild and moderate liver disease in MELD score.

Table 7 Nutritional assessment by prognostic nutritional index, controlling nutritional status among model for end-stage liver disease sodium groups

	MELD Na (mean±SD)			P^a	P^b	P^c
	Mild liver disease (*n*=60)	Moderate liver disease (*n*=23)	Severe liver disease (*n*=18)			
PNI	31.50±6.43	26.67±3.89	27.03±6.26	0.000*	0.000*	0.242
CONUT	8.66±2.27	9.86±1.29	9.45±2.11	0.006*	0.013*	0.610

CONUT, controlling nutritional status; MELD Na, model for end-stage liver disease sodium; PNI, prognostic nutritional index. ^{a}*P* value between Child mild and moderate liver disease, ^{b}*P* value between Child mild and severe liver disease, and ^{c}*P* value between Child moderate and severe liver disease. **P*-value considered statistically significant when $P < 0.05$. There is statistical difference in the PNI and CONUT between mild and moderate liver stage and between mild and sever liver stage when assessed by MELD Na score.

Figure 2



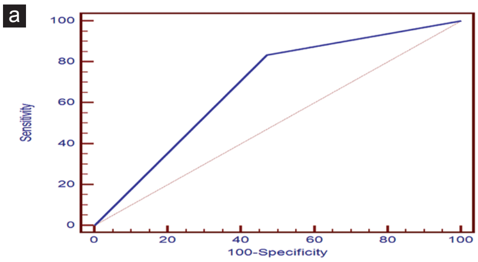
Correlation between MELD score and CHI. CHI, creatinine–height index; MELD, model for end-stage liver disease.

nutrition was more prevalent in Child A (77.3%) and in lower values of MELD and MELD Na scores (76.6 and 78.3%, respectively), and malnutrition was more prevalent in Child C (30.8%) and in higher values of MELD and MELD Na scores (37.5, 33.5%); however, no significant statistical difference can be detected between different groups of liver disease. This is compatible with Huisman *et al.* [13], where there was no significant variation in mean values of BMI and different groups of Child–Pugh score. Previous research supported that BMI is not different between Child-Pugh groups [15, 16].

In the present study, severe malnutrition (fat store depletion) assessed by TSFT was seen in 25.7% of the studied patients. This close value was consistent with the results of Tai and colleagues and Campillo and colleagues, where they reported 30 and 38.2%, respectively [17,18]. When comparing the nutritional status by TSFT in the different groups of Child score, we found that the malnutrition increased as the disease progressed from Child A to C, with no significant difference noticed between groups. Similarly, this result was seen in Roongpisuthipong *et al.* [19]. However,

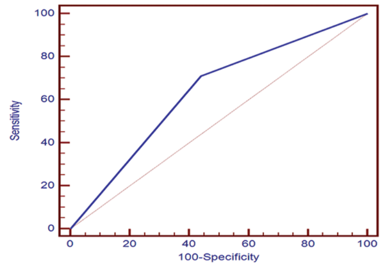
Figure 3

a



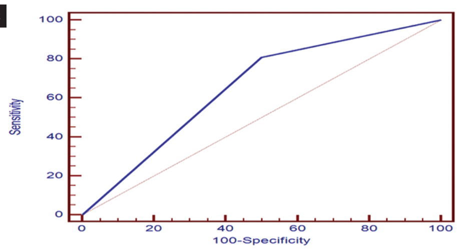
Sensitivity	Specificity	+PV	-PV	Accuracy	AUC
83.33	52.83	61.5	77.8	67.3	0.681

b



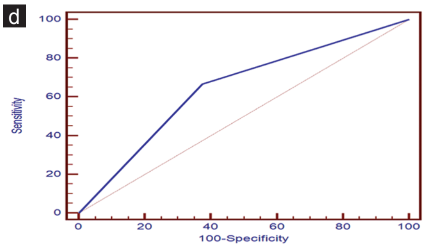
Sensitivity	Specificity	+PV	-PV	Accuracy	AUC
71.05	56.00	83.1	38.9	76.3	0.635

c



Sensitivity	Specificity	+PV	-PV	Accuracy	AUC
80.85	50.00	58.5	75.0	64.4	0.654

d



Sensitivity	Specificity	+PV	-PV	Accuracy	AUC
66.67	62.50	95.4	13.9	66.3	0.646

(a) Diagnostic accuracy of SGA versus TST with area under the curve (ROC curve 0.681). (b) Diagnostic accuracy of SGA versus MAC with area under the curve (ROC curve 0.635). (c) Diagnostic accuracy of SGA versus CHI with area under the curve (ROC curve 0.654). (d) Diagnostic accuracy of SGA versus PNI with area under the curve (ROC curve 0.646). CHI, creatinine–height index; MAC, mid-arm circumference; PNI, prognostic nutritional index; ROC, receiver operating characteristic; SGA, subjective global assessment.

in Figueiredo and colleagues and Terakura and colleagues, TSFT fell in parallel with the increasing grades of disease severity as defined by the Child–Pugh classification ($P = 0.02$) [20,21].

According to MAC and MAMC, severe malnutrition was found in 58.4 and 60.4%, respectively. Our results were higher than what was demonstrated in Fernandes *et al.* [22], who studied 129 patients with liver cirrhosis and found that 14 and 13.2% of the patients had malnutrition when assessed by MAC and MAMC, respectively. This could be owing to the low socioeconomic conditions and the poor quality of life and also the higher prevalence of decompensation in our studied population. In our present study, severe PEM was more prevalent in Child B and Child C than Child A, with a significant difference in the mean values ($P = 0.012$ and 0.030, respectively), when demonstrated by MAC, whereas it was significantly different in Child B than Child A ($P = 0.013$) when MAMC was used. This was in accordance with Vieira *et al.* [14], where there was a greater frequency of severely malnourished patients in Child–Pugh C (10/19 and 4/19), with a significant difference between nutritional groups and Child groups when MAC and MAMC analyses were demonstrated correspondingly.

Regarding the relationship between the anthropometric parameters and MELD and MELD Na scores, we found that BMI, TSFT, MAC, and MAMC were not showing significant decrease as the disease severity progressed, and that was consistent with what was established in Monsef *et al.* [23] where no significant variation in the anthropometric measurements with the MELD score was found.

Concerning the body composition analysis, 22.8% of the patients had very low fat mass percent, and the severe malnutrition was found in the higher scores of Child–Pugh, MELD, and MELD Na but without significant difference from the lower scores. Peng *et al.* [24] found dissimilar results where they studied 268 cirrhotic patients and assessed total body fat by dual-energy radiography absorptiometry and found that the percent body fat was significantly ($P < 0.05$) lower in Child–Pugh C than in Child–Pugh A.

In our study, according to CHI, we found that 94% of the patients had PEM, where only 7.9% had severe protein depletion, and also there was significant decline in mean value of CHI with the increase in Child, MELD, and MELD Na scores. This was similar to the results found in Medhat *et al.* [25] and Roongpisuthipong *et al.* [19] where the CHI differed significantly ($P = 0.025$) between the Child B and Child C groups. Moreover, Maharshi *et al.* [26] demonstrated that the CHI showed a significant correlation with liver disease severity as assessed by Child–Pugh score and MELD score ($P = 0.001$ and 0.04, respectively).

When taking the consideration of SGA, malnutrition was found in 64.4% of the population, which was opposing to Teiusanu and colleagues and Alrutz Barcelos and colleagues where 78 and 55.2% of the participants, respectively, were normally nourished [27,28]. Moreover, we found that severe malnutrition was significantly higher in Child C; however, such relation was not seen between SGA classes and groups of MELD and MELD Na scores. Elsayed *et al.* [29] demonstrated different picture where individuals who are severely malnourished had a higher Child–Pugh and MELD scores than other nutritional groups (P = 0.004). Moreover, Gaikwad *et al.* [30] showed statistical difference in MELD score between different classes of SGA (P < 0.001).

Our study showed that 98% of our populations were malnourished according to PNI and CONUT, where severe malnutrition was found 46.5 and 55.9%, respectively. Other studies such as Álvares-da-Silva *et al.* [31] showed incompatible results where 50 cirrhotic patients were involved in the study and 18.7% of the studied population had malnutrition when assessed by PNI. When comparing PNI and CONUT in different groups of liver disease, there was a significant decrease in mean value of PNI and CONUT across some groups of Child, MELD, and MELD Na scores. Similar results were shown in Taniguchi *et al.* [32] where PNI significantly decreased and the value of CONUT significantly increased according to the severity of chronic liver disease (P < 0.001).

There are some limitations that should be noted in this study. First, BMI was overestimated in cirrhotic patients owing to fluid overload. The second limitation was that the reference values for nutrition assessment were obtained from international standards which might have overestimated the degree of malnutrition. Third, several factors affect the reliability of CHI, and advanced age results in decreased creatinine excretion, and renal impairment reduces the amount of creatinine filtered through the kidney. Trauma, infection, fever, physical activity, and catabolic states increase short-term creatinine excretion, and incomplete 24-h urine collection will invalidate creatinine excretion results. The fourth limitation was the presence of ascites, and swelling of the ankles was verified by the physical examination by SGA. Although these alterations might be associated with the diagnosis of malnutrition, they could also arise from LC. For example, the reduction of the functional capacity of the patients could arise from the presence of voluminous ascites and/or from the spoliation of micronutrients due to the frequent and chronic use of diuretics. The presence of swelling could result from the reduction of albumin synthesis associated with chronic hepatic insufficiency.

In conclusion, the nutritional status of cirrhotic patients is an important tool, together with Child score and MELD score, for the prediction of prognosis of such patients, and the severity of malnutrition is associated with higher mortality. Early referral of cirrhotic patients with bad nutritional status for transplantation is recommended.

CHI is a very good predictor of muscle mass and protein contents of the hepatic patients. The PNI and CONUT could have great potential for nutritional assessment in patients with chronic liver disease, and they could be standard assessment tools in ordinary medical care, because of their simplicity.

All the nutritional assessment tools are needed together with no substitution of one method by another for the precise assessment of malnutrition among cirrhotic patients.

Finally, we recommend currying out further studies about the average daily food and calories intake and how it can improve the malnutrition and hence the severity of liver disease. This can be done by establishing a nutritional clinic where the patients can also be followed up during and after correction of malnutrition and also adding the malnutritional indices or incorporating them in the prognostic modules for evaluation of the liver severity as nutritional assessment is an integral part of clinical evaluation.

Financial support and sponsorship
Nil.

Conflicts of interest
There are no conflicts of interest.

References
1 Müller MJ. Malnutrition in cirrhosis. J Hepatol 1995; 23:31–35.
2 Caregaro L, Alberino F, Amodio P, Merkel C, Bolognesi M, Angeli P, *et al.* Malnutrition in alcoholic and virus-related cirrhosis. Am J Clin Nutr 1996; 63:602–609.
3 Krenitski J. Nutrition for patients with hepatic failure. Pract Gastroenterol 2003; 6:23–42.
4 Pugh RN, Murray-Lyon IM, Dawson JL, Pietroni MC, Williams R. Transection of the oesophagus for bleeding oesophageal varices. Br J Surg 1973; 60:646–649.
5 Malinchoc M, Kamath PS, Gordon FD, Peine CJ, Rank J, ter Borg PC. A model to predict poor survival in patients undergoing transjugular intrahepatic portosystemic shunts. Hepatology 2000; 31:864–871.
6 Kamath PS, Kim WR. The model for end-stage liver disease (MELD). Hepatology 2007; 45:797–805.
7 Cavallazzi R, Awe OO, Vasu TS, Hirani A, Vaid U, Leiby BE, *et al.* Model for end-stage liver disease score for predicting outcome in critically ill medical patients with liver cirrhosis. J Crit Care 2012; 27:424.e1–424.e6.
8 Frisancho AR. New norms of upper limb fat and muscle areas for assessment of nutritional status. Am J Clin Nutr 1981; 34:2540–2545.
9 Blackburn GL, Harvey KB. Nutritional assessment as a routine in clinical medicine. Postgrad Med 1982; 71:46–63.
10 Campillo B, Richardet JP, Bories PN. Validation of body mass index for

the diagnosis of malnutrition in patients with liver cirrhosis. Gastroenterol Clin Biol 2006; 30:1137–1143.

11 Kyle UG, Genton L, Slosman DO, Pichard C. Fat-free and fat mass percentiles in 5225 healthy subjects aged 15 to 98 years. Nutrition 2001; 17:534–541.

12 Blackburn GL, Bistrian BR, Maini BS, Schlamm HT, Smith MF. Nutritional and metabolic assessment of the hospitalized patient. J Parenter Enteral Nutr 1977; 1:11–21.

13 Huisman EJ, Trip EJ, Siersema PD, van Hoek B, van Erpecum KJ. Protein energy malnutrition predicts complications in liver cirrhosis. Eur J Gastroenterol Hepatol 2011; 23:982–989.

14 Vieira PM, De-Souza DA, Oliveira LCM. Nutritional assessment in hepatic cirrhosis; clinical, anthropometric, biochemical and hematological parameters. Nutr Hosp 2013; 28:1615–1621.

15 Chanpiwat K, Bunchorntavakul C. Nutritional assessment in patients with cirrhosis: comparison between different methods. Thai J Gastroenterol 2014; 15:90–98.

16 Rana MA, Faisal MA, Karim ME, Siddique AR, Ahmed DS, Raihan A. Assessment of malnutrition in cirrhotic patients. Bangl J Med Sci 2016; 15:189.

17 Campillo B, Richardet J-P, Scherman E, Bories PN. Evaluation of nutritional practice in hospitalized cirrhotic patients: Results of a prospective study. Nutrition 2003; 19:515–521.

18 Tai M-LS, Goh K-L, Mohd-Taib SH, Rampal S, Mahadeva S. Anthropometric, biochemical and clinical assessment of malnutrition in Malaysian patients with advanced cirrhosis. Nutr J 2010; 9:27.

19 Roongpisuthipong C, Sobhonslidsuk A, Nantiruj K, Songchitsomboon S. Nutritional assessment in various stages of liver cirrhosis. Nutrition 2001; 17:761–765.

20 Terakura Y, Shiraki M, Nishimura K, Iwasa J, Nagaki M, Moriwaki H. Indirect calorimetry and anthropometry to estimate energy metabolism in patients with liver cirrhosis. J Nutr Sci Vitaminol 2010; 56:372–379.

21 Figueiredo F, Dickson ER, Pasha T, Kasparova P, Therneau T, Malinchoc M, *et al*. Impact of nutritional status on outcomes after liver transplantation. Transplantation 2000; 70:1347–1352.

22 Fernandes SA, Bassani L, Nunes FF, Aydos MED, Alves AV, Marroni CA. Nutritional assessment in patients with cirrhosis. Arq Gastroenterol 2012; 49:19–27.

23 Monsef WA, Mostafa I, Zaky D. Assessment of the nutritional status of the Egyptian patient with end stage liver disease prior to liver transplantation. Open J Gastroenterol 2014; 04:11.

24 Peng S, Plank LD, McCall JL, Gillanders LK, McIlroy K, Gane EJ. Body composition, muscle function, and energy expenditure in patients with liver cirrhosis: a comprehensive study. Am J Clin Nutr 2007; 85:1257–1266.

25 Medhat AS, Ahmed AO, Thabet AF, Amal M. Creatinine height index as a predictor of nutritional status among patients with liver cirrhosis. J Public Health Epidemiol 2016; 8:220–228.

26 Maharshi S, Sharma BC, Srivastava S. Malnutrition in cirrhosis increases morbidity and mortality. J Gastroenterol Hepatol 2015; 30:1507–1513.

27 Alrutz Barcelos ST, Dantas-Corrêa EB, Aires Alencar ML, Lucca Schiavon LD, Narciso-Schiavon JL. Clinical and laboratory characteristics of cirrhotic patients associated with moderate and severe malnutrition. Rev Chil Nutr 2014; 41:139.

28 Teiusanu A, Andrei M, Arbanas T, Nicolaie T, Diculescu M. Nutritional status in cirrhotic patients. Mædica 2012; 7:284–289.

29 Elsayed EY, Mohamed IE, Ezzat IM. Effect of nutrition on prognosis of Egyptian cirrhotic patients. Int J Bioassays 2015; 4:4499–4503.

30 Gaikwad NR, Gupta SJ, Samarth AR, Sankalecha TH. Handgrip dynamometry: a surrogate marker of malnutrition to predict the prognosis in alcoholic liver disease. Ann Gastroenterol 2016; 29:509–514.

31 Álvares-da-Silva MáR, Reverbel da Silveira T. Comparison between handgrip strength, subjective global assessment, and prognostic nutritional index in assessing malnutrition and predicting clinical outcome in cirrhotic outpatients. Nutrition 2005; 21:113–117.

32 Taniguchi E, Kawaguchi T, Otsuka M, Uchida Y, Nagamatsu A, Itou M, *et al*. Nutritional assessments for ordinary medical care in patients with chronic liver disease. Hepatol Res 2013; 43:192–199.