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Nutritional Assessment and Clinical Determinants in Patients Awaiting Liver Transplant

S. S. SAFEENA BEEVI[1], BIJU POTTAKKAT[1]*

[1]Department of Surgical Gastroenterology, Jipmer, Puducherry, India.

Abstract

Background: Malnutrition is a usual problem in liver cirrhosis patients, progressing with advancement of disease. Protein-calorie malnutrition is related with illness and death, and the value of nutritional status assessment tools for malnutrition is debated. We conducted this study to monitor undernutrition assessment among cirrhotics using subjective global assessment (SGA) and standard anthropometric parameters and to observe the association of different clinical characteristics with SGA score and Child-Pugh classification. Methods: Patients enrolled wereend-stage liver disease (ESLD) patientsand obtained informed consent. The nutritional screening was performed using the SGAand standard anthropometry along with mid-upper arm circumference (MUAC), mid-arm muscle circumference (MAMC), triceps skin fold thickness (TST), and hand grip strength (HGS). Results: 141 ESLD patients awaiting liver transplant (LT) were enrolled in the study and among them, 113 (80.1%) were males and 28 (19.9%) females. Patient's average age at presentation was 49.5 years. Alcoholism was the major etiological factor (51.1%) and its median duration was 10 years. The liver disease severity as per Child-Pugh classification was as follows: the majority, 66 (46.8%), were in Child-Pugh category B, and 27 (19.1%) were in Child-Pugh category C. The comparison of nutritional parameters with the Child-Pugh classification showed a statistical significance ($P<0.05$) with BMI (body mass index) and MAMC between the Child-Pugh categories. The comparison of SGA nutrition scores shows that it does not significantly differ on average between gender, Child-Pugh classification, aetiologies, co-morbidity, oedema, and ascites status. The nutritional score was further categorized as normal, moderately malnourished, and severely malnourished based on the SGA score, and it shows that the nutritional level is significantly correlated with Child-Pugh classification and co-morbidity. The level of liver function parameters was not correlated with the level

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CONTACT Biju Pottakkat bijupottakkat@gmail.com Department of Surgical Gastroenterology, Jipmer, Puducherry, India.

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of different nutritional parameters. Conclusion: SGA and HGS can be used as an easy and economical tool for evaluating the level of nutrition among cirrhotics and can be consistently used in liver clinics for malnutrition screening, and one can plan for nutrition education and counselling. Nutritional level monitoring is challenging in patients with ESLD due to fluid retention, and SGA will be a better nutritional screening tool for nutritional assessment.

Introduction

ESLD patients waiting for transplantation will often have metabolic alterations of nutrients, leading to a decline in the outcome and patient wellness.[1,2] Liver decompensation causes less nutritional consumption and metabolic changes characterized by accelerated calorie utilization, less glycogen storage, elevated starvation reaction, and protein catabolism, promoting wasting of fat and muscles. Malabsorption renders the cirrhotic patient unable to utilize the ingested food completely. Controlling malnutrition efficiently is a considerable challenge in cirrhotic patients, specifically as the disorder advances.[3]

Malnutrition is diagnosed as an independent threat component for patient illness and death. It is linked to various problems such as variceal bleeding, encephalopathy, and altered liver regeneration capability, as well as a socioeconomic burden on the health care system and family.[1,4,5] The appropriate evaluation of patients with cirrhosis could be very hard, and gaining an understanding of nutritional status will help combat inappropriate nutritional losses and enables stabilization of the patient's dietary status.[6] Unfortunately,it is difficult and quite hard to evaluate malnutrition in a day-to-day medical exercise because of fluid retention and a shortage of suitable evaluation methods. Because of the high incidence of malnutrition amongst cirrhotics, performing a dietary assessment is essential. SGA is the commonly used nutrition status evaluation tool for LTpatients. Patients are categorized as well nourished, moderate, or severely malnourished. SGA used for determining undernutrition in ESLD patients has indicated very low sensitivity with high specificity. Hasse JM[7] proposed SGA as a consistent and sensitive tool for monitoring of nutritional levels in patients awaiting LT. The European Society for Clinical Nutrition and Metabolism (ESPEN)[8] advocated the usage of SGA to assess severity of malnutrition as it is a simple device in conjunction with simple anthropometric parameters. These parameters are MUAC, MAMC, and TST. HGS evaluation with the aid of a dynamometer may be used as a quick reliable, and smooth technique to identify undernutrition among ESLD patients. Nutritional assessment is of utmost importance in ESLD patients as nutritional therapy improves the nutritional status, reduces complications, and augments survival.[8-10] Our study aimed to assess the nutritional levels of ESLD subjects using clinical parameters, SGA, and other nutrition screening parameters and to check the association of nutritional status by SGA with Child-Pugh classification and clinical characteristics and also correlate with liver function parameters as nutritional assessment is a neglected area. Given the difficulties in assessing level of nutritionin liver cirrhosis patients, we preferred to use SGA as a malnutrition assessment tool for this study.

Materials and Methods

A single-centre study assessed in ESLD patients who visited the liver clinic and LT clinic of JIPMER, Puducherry. The inclusion criteria were patients between 18–68 years of age, waiting for their first liver transplant. The exclusion criteria were patients with fulminant or sub-acute fulminant hepatic failure, hepatocellular carcinoma, and those with other comorbidities such as heart failure and chronic kidney failure.

The institutional ethical committee (Human studies) approval was obtained for the study (JIP/IEC/2018/502). The estimated sample size was 141 with an expected drop-out of 10%, and it is estimated at a 5% level of significance and 80% power. Patients were enrolled between February 2020 and March 2021 after obtaining written informed consent.

Disease severity was calculated by the Child-Pugh score and model for end-stage liver disease-sodium (MELD-Na) score using an online calculator (https://www.mdcalc.com). The Child-Pugh score was estimated on the basis of three biochemical parameters (total bilirubin, albumin, INR (international normalized ratio) and two clinical parameters (ascites and encephalopathy).[11]

Nutritional assessment was performed using SGA on the basis of patient's medical history and clinical examination. The components of SGA assessment were (i) related to the medical history of the patients, such as recent changes in weight (in one month), food intake during one-month, gastro intestinal symptoms for the previous two weeks, alterations in functional capacity for one month, and metabolic demand; (ii) based on physical examination, namely loss of sub cutaneous fat and muscle wasting, oedema, and ascites.[9,12] Patients are classified as 'well-nourished', being grade A (score 7–14), 'moderately malnourished' as grade B (score 15–28), and 'severely malnourished' as grade C (score 29–35). In a previous study, body mass index (BMI) was estimated by means of dry weight.[13,14] However, in our study, BMI was not calculated based on the dry weight. The MUAC was measured on the non-dominant (left arm) in centimetres, half way from the tip of the acromion to olecranon process, using standard measuring tape. A skinfold calliper (Slim Guide Skinfold Calliper-Red with Book Model C-120R) was used to measure the TST to the nearest millimetre on the nondominant arm. Mean of three values were taken for the MUAC and TST. MAMC was estimated with the formula {MAMC = MUAC - (3.145x TST)}.[15] Voluntary muscle strength or HGS was assessed on the dominant hand, using a digital hand dynamometer (Camry Model: EH101), and mean of three values were taken, and the results were expressed inkilogram. The measurement was taken with the patient sitting down and the elbow flexed at 90º and the arm along the body.[16] Hand grip strength turned out to be the single method that forecasted a substantial occurrence of predominant problems in one year among malnourished cirrhotics.[17,18] HGS is a quick, less costly, and efficient technique to identify malnourishment in cirrhotic patients, because it can easily detect the cirrhotics more prone to develop complications.[17,18] The liver function parameters were tested on all patients namely total bilirubin, direct bilirubin, aspartate amino transferase (AST), alanine amino transferase (ALT), alkaline phosphatase (ALP), and gamma-glutamyl transferase (GGT), and its correlation with nutritional status was assessed.

Statistical analysis was accomplished using SPSS Statistics version 19 software. All categorical variables were stated as frequency and proportions, and the quantitative variables were expressed as mean ± SD or median with an interquartile range based on the normality of the data. The normality of data was assessed using the Kolmogorov-Smirnov test. The association between the categorical variables was done using the chi-square test. The comparison of the quantitative variables between the groups was conducted using the independent students' t-test, and the comparison between more than two groups was carried out using a one-way analysis of variance. The Spearman rank correlation was used to identify the relationship between the variables. All statistical analyses were measured at a 5% level of significance, and a p-value <0.05 was assumed significant.

Results

141 participants diagnosed with ESLD waiting for LT were enrolled in the study. Among these, 113 (80.1%) were males and 28 (19.9%) females. The average age of presentation was 49.5 years. Major aetiologies of ESLD were alcoholism (51.1%), followed by cryptogenic (21.3%), hepatitis B, and C (21.3%). Out of 141 study subjects, 35 (24.8%) had co-morbidities with either diabetes mellitus, hypertension, hypothyroidism, coronary heart disease, malignancy, or a combination of these. Majority, 131 (92.9%) were non-vegetarians; 75 (53.2%) were alcoholics and 12 (4.5%) were smokers. The median duration of alcoholism was 10 years, and the median abstinence from alcoholism and the median duration of liver disease were 12 months.

The liver disease severity of the patients was categorized as per the Child-Pugh's score; 48 patients (34%) belonged to the category of Child-Pugh A, 66 (46.8%) belongedto the category of Child-Pugh B, and the remaining 27 (19.1%) belonged to the category of Child-Pugh C. The median MELD - Na score among the study subjects was 16. It was observed that 81 (57.4%)

patients had lower leg oedema and95 patients (67.4%) had ascites. Among the patients, 56% had normal BMI, and 6.4% had mild to severe thinness as per the World Health Organization (WHO) BMI classification. The mean MUAC and MAMC were 25.16 cm and 20.99 cm, respectively. The mean TST and HGS were 13.29 mm and 23.24 kg, respectively. The hand grip strength of all patients was in the <10th percentile range with low muscle strength. The mean nutritional score assessed by SGA was 16.04 (+3.5). The nutritional score was further categorized as well-nourished (SGA-A), moderate malnourishment (SGA-B), and severe malnourishment (SGA-C). Of the participants, 100 (70.9%) were identified as moderately malnourished, and the remaining 41 (29.1%) were normal, and none had severe malnutrition as per nutritional assessment by SGA. The details of the socio-demographic and disease characteristics are highlighted in Table-1, 2.

Table: 1. Distribution of demographic and clinical characteristics of ESLD patients (Categorical variables) (N=141)

Clinical characteristics	Category	Number (%)
Gender	Males	113 (80.1%)
	Females	28 (19.9%)
Aetiology	Alcoholism	72 (51.1%)
	Cryptogenic	30 (21.3%)
	Hepatitis (B&C)	30 (21.3%)
	Others	9 (6.3%)
Child-Pugh classification	Class A	48 (34%)
	Class B	66 (46.8%)
	Class C	27 (19.1%)
BMI	Normal	79 (56%)
	Mild to Severe Thinness	9 (6.4%)
	Over weight	36 (25.5%)
	Obese	17 (12.1%)
Co-morbidity	Yes	35 (24.8%)
	No	106 (75.2%)
Alcoholism	Yes	75 (53.2%)
	No	66 (46.8%)
Smoking	Yes	12 (8.5%)
	No	129 (91.5%)
Oedema	Yes	81 (57.4%)
	No	60 (42.6%)
Nutritional status, SGA	A	A – 41 (29.1%)
	B	100 (70.9%)
	C	0

Table: 2: Distribution of clinical and demographic characteristics of patients with ESLD (Quantitative variables) (N=141)

Clinical variables	Mean (SD)/Median (Q1,Q3)
Age (in years) *	49.45 (10.37)
Duration of alcoholism in years**	10 (9,15)
Abstinence of alcoholism in months **	12 (6,24)

Duration of disease in months**	12 (6,24)
MELD-Na score**	16 (10,19)
Weight (Kg)*	66.73 (14.14)
Height (cm)*	164.75 (7.86)
MUAC (cm)*	25.16 (4.04)
MAMC (cm)*	20.99 (2.91)
TST (mm)*	13.29 (6.28)
Handgrip strength (Kg)*	23.24 (6.85)

*Expressed as Mean (SD)
**Expressed as Median (Q1,Q3)

The distribution of liver function parameters is presented in Table 3. The median (IQR) total bili rubin and direct bili rubin among the patients were 1.94 (2.1), and 0.59 (1.0), respectively. The median AST,ALT, and ALT values were 49 (42.5), 28 (19), and 127 (64), respectively. The median GGT level was 45 (47.5) among patients with ESLD.

Table: 3: Distribution of liver function in patients with ESLD (N=141)

Liver function parameters	Median (IQR)
Total Bilirubin (mg/dL)	1.94 (2.1)
Direct Bilirubin (mg/dL)	0.59 (1.0)
AST (IU/L)	49.0 (42.5)
ALT (IU/L)	28.0 (19.0)
ALP (IU/L)	127.0 (64.0)
GGT (IU/L)	45.0 (47.5)

The details on the comparison of different nutritional parameters with Child-Pugh classification are presented in Table 4. The comparison of the BMI among the participants with various Child-Pugh classification shows that the BMI among the patients with Child-Pughcategories A, B, and C were 23.4, 24.2, and 27, respectively. This indicates that the BMI was significantly increased (P<0.05) overall with an increase in the disease severity assessed by the Child-Pugh classification. The comparison of other nutritional parameters such as MUAC, TST, and HGS was also marginally higher among the patients with Child-Pugh categories, even though not significantly different (P>0.05) between the Child-Pugh categories overall. The average value of MAMC was found to significantly differ (P<0.05) between the Child-Pugh classification and overall.

Table 4: Comparison of nutritional parameters according to Child-Pugh Classification (N=141)

Nutritional Parameters	Child A (n=48) Mean (SD)	Child B (n=66) Mean (SD)	Child C (n=27) Mean (SD)	P-value
BMI	23.4 (3.1)	24.2 (5.1)	27 (4.8)	< 0.01*
MUAC	25.0 (2.9)	24.6 (4.6)	26.7 (4.1)	0.07
MAMC	20.9 (2.7)	20.5 (2.9)	22.4 (2.9)	< 0.01*
TST	13.2 (5.4)	13.1 (7.0)	13.8 (5.9)	0.90
HGS	24.9 (7.9)	22.3 (5.8)	22.7 (6.7)	0.13

*Statistically significant (p<0.05)

The SGA nutrition score between different clinical characteristics is compared in Table 5. The mean (SD) nutritional scores among the participants with Child-Pugh categories A, B, and C were 15.3 (3.3), 16.4 (3.6), and 16.5 (3.6), respectively. It shows that the nutritional score marginally increased with an increase in progression of the disease by Child-Pugh classification, but the disparity was not statistically important (P>0.05). The average nutritional score among males was 15.8 (3.5) and among females it was marginally higher at 17.2 (3.4), and the nutrition score was not statistically meaningful between gender (P>0.05). The mean nutritional score among the patients with co-morbidity was reported as 16.7 (2.6) and among the patients without co-morbidity was 15.8 (3.8), and this change also was not statistically significant (P>0.05). Likewise, the mean nutritional score was not significantly different (P>0.05) between various etiological factors, oedema, and ascites status.

Table 5. Comparison of nutritional scores assessed by SGA between different clinical characteristics

Clinical Characteristics	Category	Number (N)	Mean Nutrition score (SD)	P-value
Child-Pugh Classification	A	48	15.3 (3.3)	0.17
	B	66	16.4 (3.6)	
	C	27	16.5 (3.6)	
Gender	Male	113	15.8 (3.5)	0.06
	Female	28	17.2 (3.36)	
Co-morbidity	Yes	35	16.7 (2.6)	0.17
	No	28	15.8 (3.8)	
Alcoholism	Yes	75	16.0 (3.7)	0.98
	No	66	16.0 (3.4)	
Aetiology	Alcoholism	72	16.3(3.6)	0.42
	Cryptogenic	30	16.5 (3.7)	
	Hepatitis	30	15.3 (3.1)	
	Others	9	15.1 (3.9)	
Oedema	Yes	81	16.5 (3.7)	0.07
	No	60	15.4 (3.3)	
Ascites	Yes	95	16.3 (3.8)	0.26
	No	45	15.6 (3.0)	

*Statistically Significant (p<0.05)

The details of the association of SGA nutritional status with Child-Pugh classification and clinical characteristics were provided in Table 6. The comparison of the proportion of moderately malnourished patients with SGA categories in the Child-Pugh classification shows that Child-Pugh categories A, B, and C were 56 %, 79%, and 78%, correspondingly. It shows a significant association between Child-Pugh Classification and the SGA nutritional status among the patients (P<0.05).

Among the 113 male patients, 76 (67.3%) were reported to be moderately malnourished and among the 28 females, 24 (85.7%) were reported with moderate malnutrition. It shows that the proportion of moderately malnourished patients was marginally higher among females than males. Among 75 alcoholic patients, 51 (68%) were moderately malnourished against 49 out of 66 (74.2%) non-alcoholic patients. Regarding the association of co-morbidity with the nutritional status assessed by using SGA, 31 out of 35 (88.6%) patients with comorbidity were moderately malnourished against 37 out of 106 (65.1%) patients without any co-morbidity. This shows that the proportion of moderately malnourished patients was significantly higher (P<0.05) among the patients with co-morbidity when compared to those without

any co-morbidity. It was observed that 77.8% of the patients reporting oedema were moderately malnourished, and it was significantly higher (P<0.05) compared to the proportion of moderately malnourished patients (61.7%) among the patients without any oedema. Out of 95 patients with ascites, 71 (74.7%) were moderately malnourished, and it was marginally higher (P>0.05) compared to the proportion of moderate malnourishment (66.4%) among the patients without ascites.

The comparison of the age with nutritional status assessed by using SGA reported that the average age of patients with SGA-A is 48.9 (±10.9) years, and among the patients with SGA-B, it is 49.7 (±10.2) years. This shows that the average age is not significantly different (P>0.05) between normal and moderately malnourished patients. The mean MELD-Na score among the patients with normal nutritional status was 14.2 (±5.2) and among the moderately malnourished patients was 15.5 (±6.2). This shows that the MELD-Na score among the moderately malnourished patients is marginally higher (P>0.05) compared to the participants with normal/well-nourished nutritional status.

Table 6: Association of Nutritional status by SGA with Child-Pugh classification & clinical characteristics

		SGA Nutritional classification			
Clinical characteristics	**Category**	**Normal/ Well-nourished (SGA-A: 7–14))**	**Moderately malnourished (SGA-B: 15–28)**	**Total**	**P-Value**
Child-Pugh	A	21 (44%)	27 (56%)	48	0.02*
Classification	B	14 (21%)	52 (79%)	66	
	C	6 (22%)	21 (78%)	27	
Gender	Male	37 (32.7%)	76 (67.3%)	113	0.05
	Female	4 (14.3%)	24 (85.7%)	28	
Co-morbidity	Yes	4 (11.4%)	31 (88.6%)	35	<0.01*
	No	37 (34.9%)	67 (65.1%)	106	
Alcoholism	Yes	24 (32%)	51 (68%)	75#	0.42
	No	17 (25.8%)	49 (74.2%)	66	
Aetiology	Alcoholic#	21 (21.2%)	51 (70.8%)	72	0.84
	Cryptogenic	7 (23.3%)	23 (76.7%)	30	
	Hepatitis	10 (33.3%)	20 (66.7%)	30	
	Others	3 (33.3%)	6 (66.7%)	9	
Oedema	Yes	18 (22.2%)	63 (77.8%)	81	0.04*
	No	23 (38.3%)	37 (61.7%)	60	
Ascites	Yes	24 (25.3%)	71 (74.7%)	95	0.21
	No	16 (35.6%)	29 (66.4)	45	

#Out of 75 alcoholic patients, three were diagnosed with hepatitis infection. Therefore, these three patients' aetiology was considered hepatitis rather than alcoholism.

Table 7 provides the details on the relationship of liver function with nutritional parameters. It shows that the liver function parameters such as total bilirubin, direct bilirubin, AST, ALT, ALP, and GGT are not significantly related to BMI, MUAC, MAMC, and HGS. This shows that the liver function parameters were not considerably associated with the nutritional parameters.

Table: 7: Correlation of liver function parameters with nutritional parameters in patients with ESLD (N=141)

Variable	Total bilirubin	Direct bilirubin	AST	ALT	ALP	GGT
BMI	0.046 (0.59)	0.034 (0.69)	0.026 (0.76)	0.073 (0.39)	-0.042 (0.62)	-0.176 (0.04)*
MUAC	-0.054 (0.52)	-0.077 (0.37)	0.035 (0.68)	0.092 (0.28)	0.006 (0.95)	-0.029 (0.73)
MAMC	-0.036 (0.67)	-0.036 (0.67)	0.107 (0.21)	0.131 (0.12)	0.029 (0.74)	0.005 (0.96)
TST	-0.035 (0.68)	-0.071 (0.40)	-0.054 (0.53)	0.034 (0.69)	-0.029 (0.73)	-0.074 (0.38)
HGS	-0.114 (0.18)	-0.160 (0.06)	-0.056 (0.51)	0.001 (0.99)	0.008 (0.93)	-0.035 (0.68)
Nutritional Status	0.14 (0.10)	0.143 (0.09)	0.061 (0.47)	0.007 (0.93)	-0.048 (0.57)	-0.038 (0.65)

Correlation coefficient (p-value)
*Statistically significant($p<0.05$)

Discussion

Most of the participants in the study were males (80.1%), and the predominant aetiology of chronic liver disease was alcoholism (72%). These findings were supported in a similar study, where 61% had alcohol abuseas the etiological factor.[19] Studies showed that malnutrition is higher in advanced liver cirrhosis and cirrhosis from alcoholic aetiology. [20,21]

SGA is considered as an independent potent determinant of nutritional assessment and clinical outcome in patients undergoing LT.[22] In our experience, the nutritional assessment using SGA showed that 78.8% were moderately malnourished, and no patient had severe malnutrition. The extent of moderate malnutrition reported in our study is 78.8%, which is higher compared to other experiences.[19] Another study[23] reported that clinical evaluationwith SGA revealed a marginally higher tendency for malnourishment with advancing disease severity and in alcohol-related liver disease, even though it was not significant statistically and these findings support our study observations. The degree of malnutrition observed in this study was comparable to published data from Brazil,[20] which reported that malnutrition is higher in advanced stages of cirrhosis and with alcoholic aetiology, and another study in Thailand 24 reportedcirrhotics (38%) with TST <10th percentile. These results conclude that in cirrhosis, macro and micronutrient deficiencies are present globally, irrespective of the ethnicity/geographical distribution.[23,24]

A study conducted by Bakshi N and Singh K[25] observed that SGA showed a sensitivity of about 94.4%, and this study reported a specificity of 50.0% for SGA which is higher than that reported using other nutritional assessment tools. This study reported that SGA was the single nutritional evaluation tool showing a appreciably greater number of under nourished patients irrespective of the etiology of ESLD, and these results corroborate our study findings. The risk of malnutrition is considerably higher in the categories of Child-Pugh B and C than in Child-Pugh A. The association between nutritional level by SGA and Child-Pugh classification implies a significant association between nutrition score for malnutrition with Child-Pugh categories ($P<0.05$)). These findings are supported by a similar studyusing RFH-NPT (Royal free Hospital - Nutritional Prioritizing Tool) to assess nutritional status. They pointed out that the risk of malnutrition is significantly higher among patients with higher advancement of hepatic disease as per the Child-Pugh classification.[26] Two prognostic tools for the liver disease severity are the Child-Pugh score and the MELD-Na score. Earlier research had related higher Child-Pugh scores and MELD scores with undernourished patients[18] Our study also revealed a considerably higher rate of malnourishment in the higher Child-Pugh classification (B) by SGA and MELD-Na scores. Another study[27] pointed out that malnourishment was associated with the severity of hepatic disease, and mild to moderate malnourishment was present in 88% of patients in the category of Child-Pugh B. One

more similar study[28] reported an increased incidence of undernutrition and an increase in the severity of malnutrition as the cirrhosis severity increases. Our study supports these findings.

Finding of an ideal technique of nutritional evaluation in cirrhotics is challenging due to several conventionally used parameters, including weight, BMI, and MUAC, vary due to the liver disease severity irrespective of the level of nutrition. BMI might be the most widely used dietary evaluation method among the general people and is the best straightforward and easy method of determining malnutrition but is generally overestimated due to ascites and peripheral oedema.[20,26,28] Our study findings showed that the mean BMI was appreciably higher ($P<0.05$) among Child-Pugh A, B, and C classifications on overall and those with normal and moderate malnutrition. In our study, we could not identify any meaningful difference in MUAC with severity of liver disease, and this might be due to the presence of as cites and peripheral oedema in the legs and arms as reported by another similar study.[22]

The anthropometric measurements in our study revealed that the average value of MUAC, TST, and HGS was marginally higher among the patients with categories of Child-Pugh classes, even though it was not significantly different ($P>0.05$), which is supported by a similar study,[29] and they tested on the patient's non-dominant hand and reported that HGS did not significantly drop with advanced liver cirrhosis ($P>0.05$). Contradictory to our results, two studies[19,30] showed that HGS is significantly associated with liver disease severity, but they tested on the patients' dominant hand. The disparity between all these studies might be explained by the fact that we tested HGS on the dominant hand, similar to the study,[19,30] as against the study[29] tested on the non-dominant hand. However, it was clearly reported that there is no significant difference between dominant or non-dominant HGS values in normal subjects.[31]

Our study used quick, easy and low-cost methods to analyse nutritional status of participants even though more sophisticated approaches such as dual energy X-ray absorptiometry (DEXA) and CT scan were available to evaluate sarcopenia. Another study[32] similarly suggested recommending bedside evaluation tools such as SGA, anthropometric measurements, and bioelectrical impedance analysis, which can quantify nutritional levels as recommended by ESPEN 2006 for liver disease guidelines.[8] Álvares-da-Silva and Silveira[33] suggested that HGS and MAMC can be used for determining malnutrition in the early stages of liver cirrhosis, but in Child-Pugh C category, SGA may be the better nutritional assessment tool, and the same issupported in a similar study that SGA can be utilized for nutrition evaluation in Asian cirrhotics.[23] Another research[34] reported that anthropometric parameters such as the MAMC and HGS are recognized as better predictors of malnourishment in adult cirrhotic patients. The subjective global assessment is perhaps the supreme well-known nutrition evaluation tool for assessing the general patient population.[35]

Although we explored the level of nutrition of participants with different aetiologies, did not show any substantial disparity in malnutrition between alcoholics and non-alcoholics and is contradictory to the findings by Tai, Goh, and Mohd-Taib.[23] Co-morbidity, oedema, and progressive Child-Pugh classifications were correlated with a marginally higher malnutrition status in our study. The relationship of liver function parameters with nutritional parameters shows that the level of nutritional parameters is independent of the level of the liver function parameters.

Along with the complications of chronic liver disease, malnourishment only can further prompt to advance illness in among cirrhosis patients. Higher levels of complications with sepsis, decreased quality of life, and a decreased life span have noticed with moderate to severe malnutrition among cirrhosis patients when compared to those without cirrhosis.[36,37] The high incidence of malnourishment implies that nutrition evaluation and dietary rehabilitation need to be a vital aspect of the management of liver cirrhosis. Therefore, health care workers should specially attend to the nutritional needs of patients with cirrhosis to reducethe problems of malnutrition, which may help reduce morbidity and mortality.

LT is the mainstay for patients with ESLD. LT is a highly complex surgical procedure with the risk

of mortality and mortality. To reduce post operative complications, several strategies are employed, and correcting malnutrition is one of the most important aspects among them. Patients with ESLD may have several other co-morbidities such as diabetes, hypertension, cardiac diseases, etc. which may further complicate the nutrition therapy. A dedicated nutritional team is important to screen and assess malnutrition in chronic liver disease/ESLD patients. Our research findings will give clear inputs to the dedicated nutritional team to devise strategies for correcting malnutrition in patients waiting for LT. It also generates ideas about post-liver transplant nutritional support as well.

The limitation of our study was the small sample size and BMI was not calculated based on the dry weight. Based on our study findings, larger population-based comparative studies can be conducted for nutritional assessment by using SGA and RFT-NPT tools and to find the association of these tools with Child-Pugh classification and also with different clinical characteristics and biochemical parameters.

Conclusion

Our study results showed that SGA and HGS can be used as simple methods to determine malnutrition in patients with ESLD waiting for LT. These methods are simple and non-invasive to use in daily clinical and bedside practice. Other parameters such as BMI, MUAC, and TST may not be a good indicator for nutritional assessment as fluid retention in liver cirrhosis may overestimate the nutritional status. Therefore, the better indicator is SGA, which is recommended as a tool for nutritional assessment among patients with ESLD.

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Conflict of interest

The author(s) declares no conflict of interest.

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