Malnutrition in Cirrhosis Increases Morbidity and Mortality

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List of Abbreviations:

HE - Hepatic encephalopathy
CTP - Child Turcotte Pugh
MELD - Model for end stage liver disease
MAC - Mid arm circumference
TST- Triceps skinfold thickness
CHI - Creatinine Height Index
HG - Hand grip
SMM - Skeletal muscle mass
BFM - Body fat mass
SBP - Spontaneous bacterial peritonitis
HRS - Hepatorenal syndrome
ANOVA- One-way analysis of variance
Abstract

Background and Aims - Malnutrition is frequent in patients with cirrhosis and is associated with complications like ascites, hepatic encephalopathy, infections and death. We determined the prevalence of malnutrition by various methods and its clinical importance in patients with cirrhosis.

Methods - Consecutive patients of cirrhosis from August 2013 to February 2015 were assessed. Nutritional status was assessed by traditional model [mid arm circumference, triceps skinfold thickness, serum albumin, creatinine height index, total lymphocyte count], handgrip, and body composition analysis measuring skeletal muscle mass and body fat mass. All patients were followed up for 12 months to assess the outcome.

Results - 247 patients (age 42.10±10.14 yr, 81% male) were included in the study. Etiology of cirrhosis was alcohol in 53% patients. Prevalence of malnutrition was 59.5% according to traditional model, 66.8% by body composition analysis and 71.4% by handgrip. Nutritional status was poor in alcoholic cirrhotics vs non alcoholics as assessed by triceps skinfold thickness (9.33±2.9 vs 11.64±3.5mm; p=0.001), serum albumin (25.1±4 vs 28.1±4g/L; p=0.001) and body fat mass (7.6±3.1 vs 8.7±3.3kg; p=0.008). Prevalence of malnutrition was 12/27 (44.5%), 96/131 (73.3%) and 84/89 (94.4%) in Child class A, B and C respectively. Complications requiring hospitalization (71.3% vs 38.2%; 0.002) and mortality (41.1% vs 18.2%; p= 0.001) were more in malnourished patients compared to well nourished. Nutritional assessment parameters significantly correlated with the liver disease severity (p <0.05).
Conclusions- Prevalence of malnutrition is high in patients with cirrhosis. It is associated with increased complications and mortality.

Keywords- Alcoholic liver disease, Ascites, Encephalopathy

Introduction

Prevalence of malnutrition in chronic liver disease ranges between 10-100%, depends on severity of liver disease.\(^1,2\) Prevalence is more in patients with alcoholic cirrhosis compared to nonalcoholic cirrhotics.\(^3\) Malnutrition is seen in all clinical stages but is easier to detect in advanced stages of liver cirrhosis.\(^4\) Many patients have subtle changes such as fat soluble vitamin deficiency, anemia from iron, folate or pyridoxine deficiency, altered cell-mediated immune functions and minimal loss of muscle mass while patients with end-stage liver disease have muscle wasting, decreased fat stores and cachexia. Various mechanisms are considered to contribute malnutrition in cirrhosis such as poor oral intake, increased intestinal protein loss, decreased protein synthesis, disturbances in substrate utilization, hypermetabolism and malabsorption.\(^3,5\) Nutritional status is important predictor of morbidity and mortality in patients with advanced cirrhosis. Malnutrition also has important implications in liver transplantation and it has been demonstrated that patients with poor nutritional status before the transplant have increased postoperative complications and higher mortality.\(^6,7\) Various nutritional parameters has been used to assess the nutritional status such as anthropometry parameters [mid arm circumference (MAC), triceps skinfold thickness (TSF)], hand grip (HG), serum albumin level, creatinine height index (CHI) and total lymphocyte count.\(^8-10\) Recently electrical bioimpedance has been proposed for body composition analysis of patients with chronic liver disease.\(^8,11-13\) In view of paucity of data on prevalence of malnutrition and its relationship with morbidity and mortality in patients with liver cirrhosis as well as the absence of a gold-standard method for
nutritional evaluation in these patients, we conducted this study to determine the prevalence of malnutrition by various methods and its clinical importance in cirrhotic patients according the severity of disease.

Methods

The study protocol was approved by the institutional ethics committee. Informed consent in writing was obtained from each patient and the study protocol conformed to the ethical guidelines of the 1975 Declaration of Helsinki as reflected in a priori approval by the appropriate institutional review committee. Study was conducted at G B Pant Hospital, New Delhi, India from August 2013 to February 2015. Consecutive patients with cirrhosis attending our hospital were assessed for nutritional status. The patients of liver cirrhosis with age between 18-70 years were included in the study. Diagnosis of cirrhosis was based on clinical basis involving laboratory parameters, endoscopic evidence, sonographic findings, and liver histology, if available. Exclusion criteria were overt HE, active variceal bleed, active ongoing infection, renal impairment with serum creatinine >1.5 mg/dl, hepatocellular carcinoma and severe comorbid illness such as congestive heart failure, pulmonary disease and neurological disease.

Nutritional assessment was conducted using identical techniques concurrently, in 20 healthy control subjects as well. These healthy control subjects were recruited from patient’s relatives and hospital employees who were free from any significant medical problems. Routine blood investigations were performed to confirm good health. In this prospective study; consecutive patients with cirrhosis attending our hospital were assessed for malnutrition and followed up for 12 months to assess the outcome. During follow up, all patients received normal diet and salt restriction (<2 gram/day) was advised in patients with ascites. Diuretics, beta blockers, lactulose, rifaximin and antivirals drugs for hepatitis B and C virus were continued as before. Follow up
was done every month for assessment of complications like variceal bleeding, spontaneous bacterial peritonitis (SBP), hepatorenal syndrome (HRS) and hepatic encephalopathy (HE). Patients who developed complications required hospitalization and were treated with standard line of management.

**Nutritional assessment** - Nutritional assessment was done by anthropometry parameters (MAC and TST), Hg, serum albumin level, CHI, total lymphocyte count and body composition analysis (TBF-215, SC-240, Tanita Corporation of America, Inc.) measuring skeletal muscle mass (SMM) and body fat mass (BFM). TST was measured with a Vernier caliper at the middle point between acromion and olecranon process of the non-dominant arm, while MAC was measured with a tape at the same site as TST. The TST and MAC were measured on three occasions by the same investigator and average of three measurements was considered to reduce the error. HG was measured early in the morning with dynamometry (Accord medical products Pvt. Ltd. India) by the same investigator. Patients sat in front of the dynamometer, were instructed its use, and became familiar with the apparatus by using the dominant hand. Then, with the non-dominant hand, patient used the two shafts located in the lower part of the dynamometer. Three measurements were taken and the highest value was considered for analysis. CHI, a biochemical estimation of lean body mass (in absence of renal impairment, sepsis or trauma) was obtained by the values of creatinine in 24-h urine collections and then expressed as a percentage of deficit.

**Assessment of body composition** - Bioelectrical impedance analysis (BIA) is based on the relation between the volume of a conductor and its electrical resistance. Impedance is the opposition of a conductor to the flow of an alternating electrical current which can be measured by passing a small alternating current of <1mA (below the perception of the subject) through the
body and measuring the resulting potential difference. Leg-to-leg bio-impedance measurement has been developed recently where a low electrical current is passed between the anterior and posterior electrodes of the system, on which the subject stands bare feet. The bioimpedance relative to the subject’s stature is used to estimate the BFM and SMM.\textsuperscript{16}

Laboratory investigations including complete hemogram, coagulation profile, liver function tests, renal function tests, serum electrolytes were done along with work up for etiology of liver cirrhosis. Severity of liver disease was determined by Child Turcotte Pugh (CTP) and model for end stage liver disease (MELD) score.

**Nutritional diagnosis**

Traditional model

The traditional method classified the subject based on the score obtained summing five important traditional parameters, expressed as percentages, divided by the number of parameters according to the method of Mendenhall, et al.\textsuperscript{17} The adequate percentage of each parameter was calculated using the percentile distribution table by age and sex with 50\textsuperscript{th} percentile considered as ideal, as follows\textsuperscript{9}

\[
\text{Parameter value (\%) = measured value/50}^{\text{th}}\text{ percentile value x 100}
\]

\[
\text{Score} = (\%\text{TST} + \% \text{MAC} + \% \text{albumin} + \% \text{CHI} + \% \text{lymphocyte})/5
\]

According to traditional model malnutrition was diagnosed with score less than 80\%.

Body composition analysis
For the purpose of comparison, we established a multicompartmental score, which was obtained summing the values of the two more important compartments, SMM and BFM, expressed as percentages, and dividing by 2. The adequate percentage of each compartment was calculated using the percentile distribution table by sex and age with the 50th percentile (median) of the control group considered ideal, as follows:

\[
\text{Parameter value (\%) = \frac{\text{measured value (kg)}}{\text{control group 50th percentile value (kg)}} \times 100}
\]

\[
\text{Score = \frac{(\% \text{SMM} + \% \text{BFM})}{2}}
\]

According to body composition analysis malnutrition was diagnosed with score less than 80%.

**Hand Grip**

Hand grip was assessed by dynamometry, and malnutrition was diagnosed as results below the mean ± two standard deviation of the control group.

**Statistical analysis**

Data processing was performed by using the software packages SPSS version 19 (SPSS inc, Chicago, IL). Data were expressed as mean ± SD. For comparison of categorical variables, chi-square and Fisher’s exact tests were used, and for continuous variables, Mann–Whitney test for unpaired data and Wilcoxon sign rank test for paired data were used, as appropriate. Pearson’s correlation coefficient was used to assess correlation of nutritional parameters with liver disease severity. One-way analysis of variance (ANOVA) test was used for comparison in multiple groups. Kaplan-Meier method was used to assess the correlation of nutritional status with survival and differences between the curves being tested using the log rank test. The probability level of \( P < 0.05 \) was set for statistical significance.
Results

Of the 330 patients with liver cirrhosis, 83 were excluded as per exclusion criteria and remaining 247 patients (201 men; age, 42.10±10.14 years) were assessed for malnutrition. Etiology of cirrhosis was, alcoholic in 131 (53%) patients, hepatitis B virus related in 44 (18%), hepatitis C virus related in 25 (10%) patients while 47 (19%) had other causes. Mean MELD and CTP score were 16.93±2.7 and 8.82±1.76 respectively. Twenty seven (11%) patients were in Child’s class A, 131 (53%) Child’s class B, and 89 (36%) were in Child’s class C cirrhosis. The presence of ascites was clinically determined in 170 (68.8%) patients at the time of nutritional assessment, and all were on diuretics. Twenty healthy control subjects (12 men; age, 43.32±11.24 years) were included in the study. Patients and healthy controls were well matched for age, weight, height, and BMI. Baseline laboratory and nutritional assessment parameters are shown in Table 1.

Values of TST, MAC, CHI, serum albumin, total lymphocyte counts, HG, SMM and BFM were progressively reduced with increasing disease severity compared with healthy controls. For men of the control group, the mean SMM was 22.5±6.1 kg, and the 50th percentile (median) value was 20.2 kg. For women of the control group, mean SMM was 18.8±5.5 kg, and the median was 15.8 kg. For men in the control group, the mean BFM was 9.2±3.4 kg, and the median was 8.3 kg, whereas for women in the control group, the mean BFM was 10.6±3.5kg and the median was 8.7 kg. Our results showed that nutritional status as assessed by TST, MAC, CHI, serum albumin, lymphocytes, HG, SMM and BFM was poor in patients with child’s class B and C compared to child’s class A, P < 0.05 as shown in Table 1.

Nutritional Diagnosis
The prevalence of malnutrition varied according to the model used for assessment of nutritional status. According to traditional model 147 (59.5%) were malnourished, 9 (33.3%) in Child’s class A, 68 (51.9%) in B, and 70 (78.6%) in C, whereas 165 patients (66.8%) were malnourished according to body composition analysis, 10 (37%) in Child’s class A, 84 (64.1%) in B, and 71 (79.8%) in C. According to handgrip assessment 176 (71.3%) patients were malnourished, 8 (29.6%) in Child’s class A, 90 (68.7%) in B, and 78 (87.6%) in C. A total of 192 (77.7%) patients were malnourished using all three models, 12 (44.5%) in Child’s class A, 96 (73.3%) in B, and 84 (94.4%) in C. Malnutrition was found to be more prevalent with body composition analysis and hand grip compared to traditional model as presented in Figure 1.

Malnutrition in patients with alcoholic cirrhosis compared to nonalcoholics

Nutritional status was poor in patients with alcohol cirrhosis compared to nonalcoholics, as assessed by serum albumin, TST and BFM. However other nutritional parameters were comparable between alcoholic and nonalcoholic cirrhotic patients as shown in Table 2.

Complications and mortality on follow up

Fourty one patients (32 with malnutrition and 9 without malnutrition) were lost to follow-up at the end of 12 months. During the study period 158 patients developed complications of cirrhosis required hospitalization (137 were malnourished and 21 were well nourished, \( P = 0.002 \)) and 89 patients died (79 were malnourished and 10 were well nourished, \( P = 0.001 \)) as shown in Table 3. Complications requiring hospitalization in malnourished patients were variceal bleed with overt HE (n=49), SBP and HRS with overt HE (n=33), HRS (n=31), pneumonia with overt HE (n=13) and overt HE only (n=11) while in well nourished patients variceal bleed with overt HE (n=5), SBP and HRS with overt HE (n=8), HRS (n=4), and pneumonia with overt HE (n=4).
Patients who developed complications (n=158), 124(78.5%) were in child’s class C, 32(20.3%) in B and 2(1.2%) in A. Causes of death in malnourished patients were progressive liver failure with SBP, HRS, HE and sepsis in 64 patients and uncontrolled variceal bleed with HE in 15 patients while in well nourished patients cause was progressive liver failure with SBP, HRS, HE and sepsis in 8 patients and uncontrolled variceal bleed with overt HE in 2 patients. Patients who died (n=89), 72(80.9%) were in child class C and 17(19.1%) in B.

Nutritional status of patients significantly affect the survival at the end of 12 months, as evident by Kaplan-Meier survival curves, P =0.002 as presented in Figure 2.

**Correlation of nutritional parameters with liver disease severity**

Nutritional parameters showed negative correlations for both CTP and MELD score, but with higher correlations for the former. Among the parameters used TST, MAC, serum albumin, CHI, HG, SMM and BFM showed a significant correlation with liver disease severity as assessed by CTP score, suggesting that the lower the values for nutritional parameters, worse is the severity of liver disease. MAC, serum albumin, CHI, HG, SMM and BFM showed a significant correlation with liver disease severity, using MELD score. Total lymphocyte count was depleted in 160 (64.8%) patients, showed a weak correlation with liver disease severity for both CTP and MELD score (Table 4).

**Discussion**

Assessment of nutritional status is of crucial importance in the management of patients with liver cirrhosis. Malnutrition is common in patients with cirrhosis and has an adverse impact on prognosis. Early detection and management of malnutrition is of great clinical importance. This study showed that the body composition analysis and handgrip as a nutritional assessment
technique offers several advantages over traditional methods in patients with liver cirrhosis. Although traditional evaluations obtained by anthropometry and blood tests showed significant differences between patients and healthy controls, however these differences were underestimated when compared with the results of the body composition analysis and HG.

In our study, the overall prevalence of malnutrition obtained by the traditional model was 59.5% similar to previous studies. However, the prevalence is more with the body composition analysis (66.8%) and HG (71.3%). Previous published studies showed prevalence of malnutrition was 55 to 60% by body composition analysis and 63% by HG, which is in concurrence with our results. Traditional methods results in unreliable estimates of nutritional status in patients with cirrhosis because of increase extracellular water. Measurement of SMM and BFM by body composition analysis is independent of hydration, thus increasing the accuracy of nutritional assessment. The healthy control group was important in the comparative analysis for evaluation of malnutrition in patients with cirrhosis. But this control group did not define normal SMM, BFM and HG in our population. A statistically valid definition of “normal” (control group) must be population based and should be defined region by region.

Our results showed that nutritional status as assessed by TST, MAC, CHI, serum albumin, total lymphocyte count, HG, SMM and BFM was poor in patients with Child’s class B and C compared to Child’s class A, P < 0.05, in agreement with previous study. The nutritional status was poor in patients with alcoholic cirrhosis compared to non alcoholics as assessed by serum albumin, TST and BFM. In alcoholics, anorexia, gastrointestinal disorders, malabsorption of nutrient and intestinal alteration leads to malnutrition. Previous studies have also revealed that malnutrition is more prevalent in alcoholic cirrhosis. We analyzed the clinical outcomes of cirrhotic patients over 12 months, with an emphasis on complications of liver cirrhosis such as
SBP, HE, variceal bleeding, HRS and mortality. On follow up malnourished patients had poor outcome compared to well nourished. Among malnourished patients, 71.3% patients developed major complications requiring hospitalization compared to 38.2% well nourished patients, P=0.002. Further, in the malnourished patients, mortality was 41.1% compared to 18.2% in well nourished patients at the end of 12 months, P=0.001. These results are very relevant because patients with malnutrition, even with Child’s class A, have a significant greater risk of developing life-threatening complications. These results are in concurrence with previous studies. 19,21,25,26 Study by Sam and Nguyen27 showed the association of malnutrition with longer hospitalization (8.7 days versus 5.7 days, p<0.0001), higher in-hospital mortality and a higher rate of readmissions. In our study, nutritional parameters showed higher correlation with the CTP score than with MELD score, these results are similar to previous study.20 In the previous version of the Child-Pugh criteria, malnutrition level was considered as an indicator; however, the absence of an accurate tool for nutritional diagnosis has led to its exclusion but albumin is still one of the parameters of CTP score. MELD score so far, does not take nutritional status into account. According to Stickel et al28, this model fails to predict survival possibly in 15-20% recipients of liver transplants for not considering the nutritional status. A significant correlation of SMM and BFM with liver disease severity was also observed, and lowers the SMM and BFM, worse was the disease severity, similar to the results observed by Selberg and Selberg.29

In conclusion prevalence of malnutrition is high in cirrhotic patients. Nutritional status was poor in alcoholic cirrhotics compared to non alcoholics. HG and body composition analysis better estimate the prevalence of malnutrition compared to traditional model in these patients. Malnutrition is associated with increase morbidity and mortality in patients with cirrhosis. The nutritional parameters significantly correlated with the liver disease severity.
Financial support and conflict of interest – None

References


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27. Sam J, Nguyen GC. Protein-calorie malnutrition as a prognostic indicator of mortality among patients hospitalized with cirrhosis and portal hypertension. Liver Int 2009;29(9):1396-1402.


**Figure legends**

Figure 1 - Prevalence of malnutrition by various methods. TM, traditional model; BCA, body composition analysis; HG, handgrip

Figure 2 - Cumulative survival in well nourished (dotted line) and malnourished (continuous line) cirrhotic patients (log rank; P=0.002).
Table 1: Baseline laboratory and nutritional assessment parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Control (14/6)</th>
<th>Cirrhosis class (Male/Female)</th>
<th>P value&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Child A (21/6)</td>
<td>Child B (103/28)</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>57.2±8.1</td>
<td>55.9±7.8</td>
<td>52.9±8.1</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>165.2±6.1</td>
<td>162.1±6.3</td>
<td>164±6.9</td>
</tr>
<tr>
<td>BMI</td>
<td>20.96±3.8</td>
<td>20.8±3.5</td>
<td>20.2±3.9</td>
</tr>
<tr>
<td>TST (mm)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>11.6±3.9</td>
<td>11.31±3.6</td>
<td>11.0±3.2</td>
</tr>
<tr>
<td>Women</td>
<td>15.1±4.8</td>
<td>14.5±3.9</td>
<td>13.2±3.8</td>
</tr>
<tr>
<td>MAC (cm)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>23.2±3.6</td>
<td>20.8±3.3</td>
<td>20.3±4.1</td>
</tr>
<tr>
<td>Women</td>
<td>20.1±3.7</td>
<td>18.2±3.2</td>
<td>17.4±3.5</td>
</tr>
<tr>
<td>CHI (%)</td>
<td>90.2±11.5</td>
<td>68.8±12.2</td>
<td>64.4±11.5</td>
</tr>
<tr>
<td>Albumin (g/L)</td>
<td>39.0±4</td>
<td>29.1±3</td>
<td>27.9±3</td>
</tr>
<tr>
<td>Lymphocytes (x10^9 cells/L)</td>
<td>2.04±0.83</td>
<td>1.38±0.75</td>
<td>1.09±0.64</td>
</tr>
<tr>
<td>Hand grip (kg)</td>
<td>15.5±3.8</td>
<td>12.3±3.6</td>
<td>11.2±3.3</td>
</tr>
<tr>
<td>Skeletal muscle mass (kg)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>22.5±6.1</td>
<td>20.5±5.6</td>
<td>19.0±5.4</td>
</tr>
<tr>
<td>Women</td>
<td>18.8±5.5</td>
<td>16.7±5.4</td>
<td>15.6±4.9</td>
</tr>
<tr>
<td>Body fat mass (kg)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
(BMI, body mass index; TST, triceps skinfold thickness; MAC, mid arm circumference; CHI, creatinine height index; a comparison among four groups by analysis of variance; P value <0.05 for Triceps skinfold thickness, MAC, CHI, albumin, lymphocytes, handgrip, skeletal muscle mass and body fat mass in both sex child A vs child B and C)
Table 2: Comparison of nutritional status between alcoholic cirrhosis versus nonalcoholics

<table>
<thead>
<tr>
<th></th>
<th>Alcoholic (n=131)</th>
<th>Non alcoholic (116)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMI</td>
<td>20.1±3.8</td>
<td>20.3±3.7</td>
<td>0.4</td>
</tr>
<tr>
<td>TST (mm)</td>
<td>9.33±2.9</td>
<td>11.64±3.5</td>
<td>0.001</td>
</tr>
<tr>
<td>MAC (cm)</td>
<td>19.8±3.1</td>
<td>20.3±3.3</td>
<td>0.15</td>
</tr>
<tr>
<td>CHI (%)</td>
<td>62.1±9.6</td>
<td>64.1±11.9</td>
<td>0.16</td>
</tr>
<tr>
<td>Albumin(g/L)</td>
<td>25.1±4</td>
<td>28.1±4</td>
<td>0.001</td>
</tr>
<tr>
<td>Lymphocytes(x10^9 cells/L)</td>
<td>1.01±0.54</td>
<td>1.18±0.61</td>
<td>0.08</td>
</tr>
<tr>
<td>Hand grip(kg)</td>
<td>10.3±3.2</td>
<td>10.6±3.6</td>
<td>0.37</td>
</tr>
<tr>
<td>Skeletal muscle mass(kg)</td>
<td>17.7±5.1</td>
<td>18.4±5.5</td>
<td>0.25</td>
</tr>
<tr>
<td>Body fat mass(kg)</td>
<td>7.6±3.1</td>
<td>8.7±3.3</td>
<td>0.008</td>
</tr>
</tbody>
</table>

(BMI, body mass index; TST, triceps skinfold thickness; MAC, mid arm circumference; CHI, creatinine height index)
Table 3 Complications and mortality at the end of 12 months

<table>
<thead>
<tr>
<th></th>
<th>Malnourished patients (n= 192)</th>
<th>Well nourished patients (n=55)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loss to follow up n (%)</td>
<td>32 (16.7)</td>
<td>9 (16.3)</td>
<td>0.98</td>
</tr>
<tr>
<td>Complications n (%)</td>
<td>137 (71.3)</td>
<td>21(38.2)</td>
<td>0.002</td>
</tr>
<tr>
<td>Death n (%)</td>
<td>79 (41.1)</td>
<td>10 (18.2)</td>
<td>0.001</td>
</tr>
</tbody>
</table>
Table 4 Correlation of nutritional parameters with liver disease severity

<table>
<thead>
<tr>
<th></th>
<th>TST</th>
<th>MAC</th>
<th>Albumin</th>
<th>CHI</th>
<th>Total lymphocyte count</th>
<th>Hand grip</th>
<th>SMM</th>
<th>BFM</th>
</tr>
</thead>
<tbody>
<tr>
<td>CTP score</td>
<td>r</td>
<td>-0.241</td>
<td>-0.338</td>
<td>-0.612</td>
<td>-0.387</td>
<td>-0.132</td>
<td>-0.302</td>
<td>-0.436</td>
</tr>
<tr>
<td>P value</td>
<td>0.03</td>
<td>0.01</td>
<td>0.001</td>
<td>0.01</td>
<td>0.12</td>
<td>0.01</td>
<td>0.001</td>
<td>0.001</td>
</tr>
<tr>
<td>MELD score</td>
<td>r</td>
<td>-0.151</td>
<td>-0.182</td>
<td>-0.349</td>
<td>-0.184</td>
<td>-0.083</td>
<td>-0.293</td>
<td>-0.310</td>
</tr>
<tr>
<td>P value</td>
<td>0.10</td>
<td>0.04</td>
<td>0.01</td>
<td>0.04</td>
<td>0.36</td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
</tr>
</tbody>
</table>

(r, correlation coefficient; TST, triceps skinfold thickness; MAC, mid arm circumference; CHI, creatinine height index; SMM, skeletal muscle mass; BFM, body fat mass)
Figure 1

![Bar graph showing the prevalence of malnutrition among different groups: TM, BCA, HG, and TM+BCA+HG.](image-url)
Figure 2

A Kaplan-Meier survival curve showing the follow-up period (in months) for two groups: Malnourished and Well nourished. The number of patients at each follow-up point is indicated as follows:
- Malnourished: 192, 182, 169, 154, 140, 129, 113
- Well nourished: 55, 55, 54, 51, 49, 47, 45