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## Malnutrition and liver disease in a developing country

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### Abstract

Malnutrition is a highly prevalent and under recognized condition in developing countries of South Asia. The presence of malnutrition causes a severe impact on patients with liver cirrhosis. The etiology of cirrhosis differs in the South Asian region compared to the West, with hepatitis B and C still being the leading causes and the prevalence of nonalcoholic fatty liver disease increasing over time. Comorbid malnutrition worsens outcomes for cirrhosis patients. Urgent attention to address malnutrition is needed to improve patient outcomes. The etiology and pathophysiology of malnutrition in liver diseases is multifactorial, as reduction in liver function affects both macronutrients and micronutrients. A need for nutritional status assessment for liver disease patients exists in all parts of the world. There are many widely studied tools in use to perform a thorough nutritional assessment, of which some tools are low cost and do not require extensive training. These tools can be studied and evaluated for use in the resource limited setting of a country like Pakistan. Treatment guidelines for proper nutrition maintenance in chronic liver disease exist for all parts of the world, but the knowledge and practice of nutritional counseling in Pakistan is poor, both amongst patients and physicians. Emphasis on assessment for nutritional status at the initial visit with recording of vital signs is needed. Simultaneously, treating physicians need to be made aware of the misconceptions surrounding nutritional restrictions in cirrhosis so that patient education is done correctly based on proper scientific evidence.

**Key Words:** Liver cirrhosis; Malnutrition; Nutrition assessment; Liver diseases; Nutritional and metabolic diseases; Micronutrients

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**Core Tip:** Malnutrition in liver cirrhosis is a serious problem in South Asia where the etiology differs from the Western population. As malnutrition is generally highly prevalent in the region, it causes an impact on patients with liver cirrhosis. Urgent attention to address malnutrition is needed to improve patient outcomes. Emphasis on assessment for nutritional status at the initial visit with recording of vital signs is also needed. Simultaneously, treating physicians need to be made aware of the misconceptions surrounding nutritional restrictions in cirrhosis so that patient education is done correctly based on proper scientific evidence.

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## INTRODUCTION

Malnutrition (undernutrition) is defined as an insufficient intake or assimilation of nutrients essential for development and prevention of disease[1]. Malnutrition presents as a common complication of end-stage liver failure (cirrhosis), which is characterized by mass systemic complications such as refractory ascites, spontaneous bacterial peritonitis, hepatorenal syndrome and variceal hemorrhage[2]. Due to the deterioration of health that cirrhosis causes, approximately a million people die from cirrhosis globally, making it a significant disease burden to be addressed.

Several studies have evaluated nutritional status in patients with liver cirrhosis of different etiologies and varying degrees of liver insufficiency[3,4] leading to a consensus that malnutrition is recognizable in all forms of cirrhosis[5] with the prevalence of malnutrition in cirrhosis having been estimated to range from 65%-100% [6,7]. Thus, malnutrition becomes an important prognostic indicator of clinical outcomes, which include survival rate, the length of hospital stay, post-transplantation morbidity and quality of life in patients with cirrhosis[8], particularly in patients with severe cirrhosis and alcoholic cirrhosis where malnutrition is more likely to be present[9]. While malnutrition remains potentially modifiable, it has been observed starting from the initial stages of liver disease that results in an almost direct relationship between the liver disease severity and the extent of malnutrition, with malnutrition becoming easier to detect in severe cirrhosis[10].

The causes of malnutrition in liver disease are complex and multifactorial due to the liver forming a fundamental part of the body's metabolism. It results from impaired dietary intake due to the malfunctioning liver, chronic inflammation and subsequently the altered macronutrient and micronutrient metabolism. Low patient activity is also attributed to it[7,11]. Additionally, anorexia, gastroparesis, nausea, increased leptin levels, encephalopathy and gastritis are found to be contributors of malnutrition. Ascites, frequent paracentesis, some drugs such as diuretics and lactulose, a sodium-restricted diet and alcohol consumption (decreases appetite) can also result in metabolic malfunctioning and thus contribute to a reduction in dietary intake, which leads to malnutrition in liver disease[12,13]. The deficiency of biliary salts due to liver malfunction and decreased assimilation of nutrients, abnormal motility of the digestive tract and an increased bacterial growth may subsequently lead to an impaired uptake and metabolism of nutrients, resulting in malnutrition[14]. Portal hypertension leads to an increased permeability of the intestinal mucosa, thereby causing an increased loss of proteins that may be similarly noted in cases of bleeds caused by varices or ulcers[15]. A poor nutritional status then poses significant consequences for postoperative complications among transplant candidates as well because this is an important prognosticator for mortality and morbidity among chronic liver disease (CLD) patients[9]. Subsequently, malnutrition itself becomes an independent predictor of mortality in patients with CLD.

The resultant malnutrition comprises of both macro and micronutrient deficiencies. The macronutrients (being proteins, carbohydrates and fats) have their metabolism affected[16], while protein deficiency makes patients more susceptible to hepatocellular disease, in particular. On the micronutrient level, patients with a history of cholestatic liver disease are more liable to have an insufficient calorie intake with a

higher risk of vitamin deficiencies. Detecting micro or macronutrient deficiencies at an earlier stage is crucial so that nutritional supplementation can be initiated in a timely manner, which has been proven to decrease the risk of infection and in-hospital mortality while enhancing liver function. Therefore, it has been recommended that all patients with CLD should be screened to have an early identification of those at risk of complications so that relevant interventions can be started[17].

In this article, we will be reviewing the prevalence, underlying mechanism and factors associated with malnutrition and the impact of malnutrition in cirrhosis in the setting of a developing country. This will pave the way for increased awareness regarding malnutrition in cirrhosis and its consequences to subsequently treat the patients accordingly for better outcomes.

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## MALNUTRITION IN SOUTH ASIA

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While about 2 billion people in the world are suffering from various forms of malnutrition[18], the prevalence of malnutrition due to cirrhosis is estimated to range from 65%-100% globally[6,7]. In South Asia particularly, malnutrition is rampant with a high prevalence of low adult body mass index (BMI) (23.4% in men and 24.0% in women in 2014)[19]. In this region, Pakistan in particular has 45.3 million people (28 percent of the population) being victims of food insecurity according to the National Nutrition Survey Report 2011[20]. The global nutrition report 2020 has studied the progress of attaining 10 global nutrition targets of 2025 in 194 countries (which include anemia, low birth weight, exclusive breastfeeding, childhood stunting, childhood wasting, childhood overweight, adult obesity and adult diabetes, salt intake and raised blood pressure). Progress is not assessed at the country level for salt intake and blood pressure. Data collected for 8 of the 10 targets shows that Pakistan is on track for only 2 targets out of 8. In Pakistan, more than half of children grow up stunted or wasted. Pakistan is recognizing this issue as important, as is evident by it being 1 of the 25 countries to have revisited their nutrition budget, which has resulted in allocating increased funds towards nutrition thrice since 2015. Of this, the highest increase is towards nutrition sensitive allocation of social protection. The report highlights the importance for subnational level of financing for nutrition in areas like Balochistan in Pakistan and Rajasthan in India. Pakistan and India comprise two of the three countries with the highest number of stunted children with 10.7 million stunted children in Pakistan and 25.5 million in India. This data reflects the severity of malnutrition in the region and can be extrapolated to the adult population of the South Asian countries[21].

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## LIVER DISEASES IN SOUTH ASIA

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While most of the burden of liver cirrhosis in western countries is nonalcoholic fatty liver disease, most of it for South Asian countries is related to hepatitis B and C. However, increasing prevalence of nonalcoholic fatty liver disease is being seen in the South Asian population as well[22]. A survey conducted in 2015 showed the incidence of cirrhosis in South Asia to be 21.39% overall with 6.98% being hepatitis B virus related, 4.87% hepatitis C virus related, 4.84% alcohol related and 4.69% due to other etiologies[23]. The incidence of cirrhosis is estimated to be 23.6 per 100000 in Southeast Asia in 2017[24,25]. A study comparing liver resection patients between the East and the West of the world showed that patients from the East had worse Child Pugh scores and had a more advanced stage of cancer than the West[26]. A multicenter study from India revealed that at least a third of the patients presenting with CLD present at a very advanced stage of decompensated cirrhosis[27].

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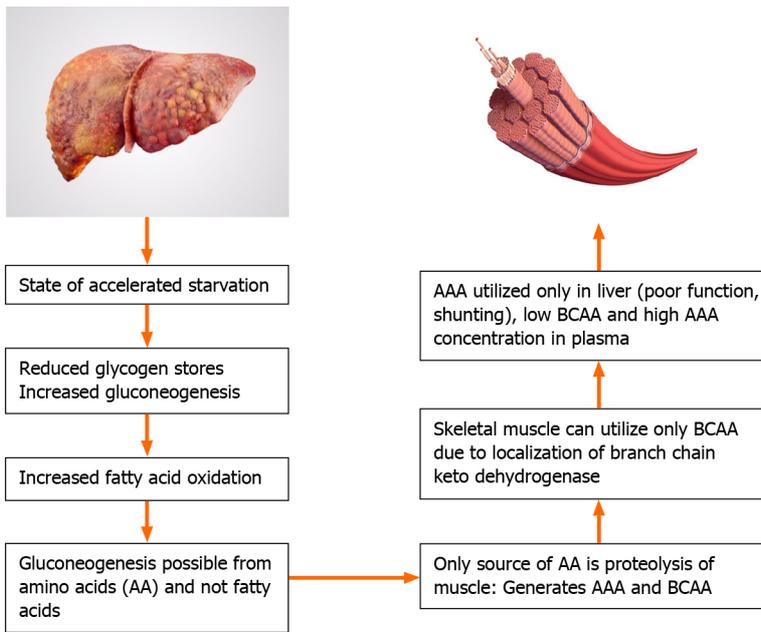
## ETIOLOGY AND PATHOPHYSIOLOGY

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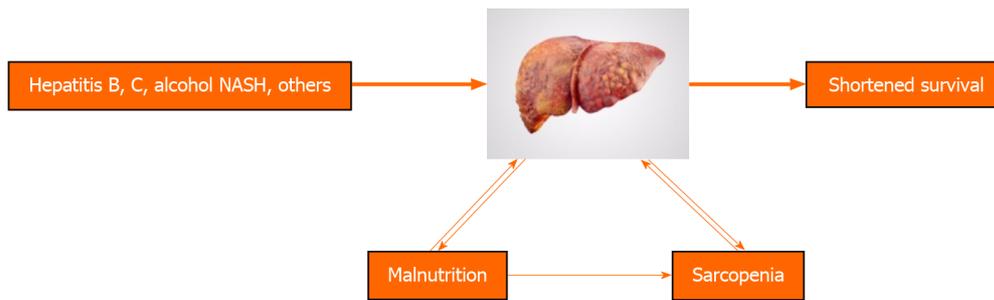
The flowcharts in Figures 1 and 2 describe the pathophysiology of malnutrition as a consequence of cirrhosis and the multiple pathways that lead to it[28].

### ***Metabolic changes occurring in CLD***

Multiple changes in nutrient metabolism are observed in cirrhosis, which subsequently contributes to malnutrition. Around 14% to 40% of patients with cirrhosis



**Figure 1 Pathophysiology of malnutrition as a consequence of cirrhosis and the multiple pathways that lead to it.** AAA: Aromatic amino acids; BCAA: Branched chain amino acids.



Inadequate dietary intake	Malabsorption	Metabolic disturbances
Nausea and early satiety	Portosystemic shunting	Hypermetabolic state
Ascites	Chronic pancreatitis	Increased sympathetic system activity
Impaired gastric and gut mobility	Associated due to alcohol abuse	Hyperdynamic circulation
Loss of appetite	Bile acid deficiency	Bacterial translocation from gut
Upregulation of leptin and TNF-alpha	Decreased production	Physical inactivity
Altered Taste	Portosystemic shunting	Obesity and other endocrine factors
Zinc deficiency	Small intestinal bacterial overgrowth	Associated sepsis and cytokine storm
Dietary restriction	GI bleeding	Increased gluconeogenesis
Salt restriction	Hypermobility	Lack of glycogen storage
Fasting for clinical investigation	Loss of protein	Breakdown of fat and muscles
Protein restriction for hepatic encephalopathy		
Alcohol dependence		
Irregular and poor eating		

**Figure 2 Pathophysiology of malnutrition as a consequence of cirrhosis and the multiple pathways that lead to it.** GI: Gastrointestinal; NASH: Nonalcoholic steatohepatitis; TNF: Tumor necrosis factor.

have been diagnosed with type 2 diabetes mellitus due to glucose intolerance or end stream resistance to insulin seen in an estimated 70% of cirrhotic patients[29]. It has also been observed that the levels of hepatic and muscle glycogen are decreased, leading to a reduction in the availability of glucose as an energy substrate, with the body switching to the consumption of fats and proteins as alternative energy sources [30].

Regarding the rest energy expenditure (REE), a measure of resting metabolic rate and defined as the energy expended to sustain homeostasis at rest, conflicting results have been reported. Up to 34% of patients have been claimed to have a REE out of range by being about 120% higher, while some results show most of the patients with a REE within range[9,31,32]. Further measuring the calorie consumption, a cross-sectional study of 473 patients with cirrhosis found that 34% had hypermetabolism, measured by indirect calorimetry. The increase in REE was associated with lean body mass and an increase in beta-adrenergic activity but not with the severity or type of liver disease. Further studies have demonstrated that hypermetabolism can persist at least 1 year after liver transplant and correlates with a reduction in survival, also indicating prognosis[33]. Ascites can also contribute to an increase in REE due to which its removal results in a significant reduction in the REE when measured by indirect calorimetry. The mechanism underlying this observation is unclear[34].

The muscle plays a significant role in metabolism particularly of amino acids (AA). It also constitutes an important site for glutamine synthesis and gluconeogenesis. It should be noted that gluconeogenesis plays a direct role in the destruction of muscle tissue, with the body deriving protein substrates from the muscle for metabolism. This destruction of muscle subsequently causes a decrease in the synthesis of proteins and in its break down, also causing these patients to become protein deficient. Therefore, the most common complication of cirrhosis is a presentation of sarcopenia, observable in almost 60% of patients[35,36]. The ratio of branched chain AA (BCAA) to aromatic AA declines in CLD. A similar effect is seen in sepsis and major trauma. It is due to this change that malnourished individuals often develop hepatic encephalopathy (HE). This has established sarcopenia as an important risk factor for HE[36,37]. Further contributing to the increase in the consumption of AA by the muscles is the factor of any overnight fast that promotes an increase in ketogenesis and gluconeogenesis, even with lipids representing 75% of the calories expended during such a period. Healthy subjects after 3 d of fasting may also have a similar effect, but it occurs much slower when compared with cirrhotic patients[38].

There is an overall loss of protein from reduced synthesis of urea and hepatic proteins, reduced intestinal protein absorption and increased urinary nitrogen excretion[39]. The deficiency of AA and thus proteins gives rise to specifically a protein-calorie malnutrition (PCM). Each stage of CLD is affected by PCM with PCM being present in 65%-90% of patients with advanced disease. PCM also detrimentally causes systemic complications. There is an increased risk of HE and hepatorenal syndrome, while esophageal varices may often be seen as well. There is also a reduced regeneration capacity of the liver with a declining trend of liver function and an increased risk of surgical morbidity as well as mortality, all due to the protein and AA deficiency causing subsequent metabolic dysfunction[40,41].

Peripheral insulin resistance and  $\beta$ -cell dysfunction due to abnormal cell signaling pathways in cirrhotic patients leads to pancreatic dysfunction, giving rise to hepatogenous diabetes, steatorrhea and overall pancreatic disease[42,43]. The improper carbohydrate metabolism preferentially causes lipids to be oxidized instead for energy. This increases lipolysis and fatty acid oxidation, while an increase in the production of ketones may also occur. Therefore, reduced levels of plasma triglycerides, phospholipids, cholesterol, apoproteins and polyunsaturated fatty acids occurs in cirrhotic patients over time. These decreasing levels can be correlated with the severity of the liver disease, becoming an independent predictor of mortality in alcoholic cirrhosis. The respiratory quotient is also lowered when compared to non-diseased patients, also pointing towards poorer patient outcomes[44,45].

### **Deficiency of micronutrients**

Micronutrient deficiency is common in cirrhosis, most observed in alcoholic disease. The most common deficiency seen is that of group B vitamins. Deficient levels of micronutrients are explained mainly by a decreased oral intake, malabsorption and declining hepatic reserves[46]. Fat-soluble vitamins such as Vitamin A, D, E and K have been seen to be deficient in alcoholic disease, along with steatorrhea, cholestasis and bile salt deficiency, negatively impacting patient outcomes[12,47]. Thiamine deficiency is also often found particularly in alcoholic disease as well as other forms of cirrhosis. Intake of alcohol causes a decline in the intestinal absorption and metabolism of thiamine. This increases the risk of developing Wernicke encephalopathy and Korsakoff dementia due to a decline in neurotransmitter synthesis, nucleic acid synthesis and synthesis of steroids and fatty acids[48]. Decreasing liver reserves cause a vitamin B12 and folic acid deficiency. While the levels of vitamin B12 in the serum may be increased, decreased tissue levels are observed. Anemia, glossitis and neurological symptoms may subsequently occur[12,49].

Retinol deficiency also occurs in cirrhosis and is related with decreased absorption and impaired hepatic mobilization due to hepatic stellate cell injury. This may result in dermatitis, night blindness, dyslipidemia or photophobia and increase the risk of hepatocellular carcinoma and other neoplastic disorders[50-52]. Vitamin A supplementation should be administered carefully because its excess causes hepatotoxicity [53]. Vitamin K deficiency results from declining hepatic reserves, increasing the risk of bleeding; while vitamin D deficiency can be caused from a reduced ingestion and absorption. Absorption is impaired in underexposure to ultraviolet light as well as in cholestatic disease or portal hypertension enteropathy[54]. Patients with abnormal liver functioning have deficient vitamin D levels as hydroxylation is required to synthesis calcidiol. A significant part of the liver loses function before calcidiol production is seen to be decreased. It is due to this that patient presentation with biochemical or histological evidence of osteomalacia is rare, unless a vitamin D deficiency is present concomitantly[55,56]. Therefore, decreasing vitamin D levels directly increase the risk of patient mortality where CLD is also present. It also contributes to failure of treatment of liver diseases especially in patients being treated for hepatitis C [57].

Other deficiencies present in patients with alcoholic and nonalcoholic liver disease include that of zinc and selenium. Their supplementation has improved CLD outcomes[58]. Zinc deficiency is caused by a reduction in intake and systemic assimilation. Treatment with diuretics is also a contributor. The levels of ammonia rise in the circulation, which causes dysregulation of hepatocyte functioning and an increased risk of HE. Anorexia can also be caused with this deficiency, along with the dysfunction of the immune system[38,59]. Magnesium deficiency is also noted with alcohol consumption causing not just folate deficiency but also contributing to decreasing magnesium levels. Magnesium deficiency was observed in 30% to 80% of alcoholics. Dysfunctional magnesium transport and homeostasis in vital organs such as the brain, skeletal muscle, heart and liver can result due to alcohol intake. Often magnesuria can also occur[60]. The subsequent magnesium deficiency can cause dysgeusia and contribute to minimal HE, which further decreases the patients' intakes and worsens outcomes. Clinical improvement is therefore noted with magnesium supplementation [54]. **Table 1** summarizes the effects of each micronutrient deficiency caused by liver disease.

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## NUTRITIONAL ASSESSMENT IN CLD

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A nutritional assessment determines both the macro and micronutrient state of a patient. It is necessary to identify nutritional risks that affect morbidity and mortality and helps develop a targeted therapy to benefit the patient.

Malnutrition is more evident in decompensated compared to compensated cirrhosis. The 2019 European Association for the Study of the Liver guidelines recommend a screening of all advanced CLD patients for malnutrition (undernutrition), as it is a recognized complication of liver cirrhosis. Criteria for patients at high risk of malnutrition are: (1) a BMI < 18.5 kg/m<sup>2</sup>; and (2) advanced decompensated cirrhosis (Child-Pugh C patients)[57].

Thus, an assessment and diagnosis of malnutrition should be done thoroughly starting with a detailed history and physical examination. A thorough history can help identify poor intake, eating habits, loss of appetite, weight changes and any episodes of diarrhea and malabsorption as a potential source of malnutrition in a patient. Calculation of the patient's BMI and determination of the Child Pugh Score for severity of disease is also important with the history, as a direct correlation exists between severity of disease and malnutrition. A physical examination also provides insight about any macro and micronutrient deficiencies. Specific physical findings, such as pallor in iron deficiency anemia, are very important to observe and record[9, 61].

Skeletal muscle loss (sarcopenia) has been established as the most common complication of cirrhosis[59]. It is associated with severe outcomes in patients with liver cirrhosis and is considered useful for the global assessment of patients with CLD, therefore a physical examination for it is important[62]. A multitude of different standardized nutritional status assessment tools also exist that can be used for examination.

### **Subjective global assessment scale**

This includes components of history and physical exam and does not rely on any lab

**Table 1 Effects of each micronutrient deficiency caused by liver disease**

Micronutrient	Effect caused by deficiency in liver disease
Vitamin A	Dermatitis, night blindness, dyslipidemia, photophobia, increased risk of neoplasia
Vitamin B1	Wernicke encephalopathy and Korsakoff dementia
Vitamin B9	Dementia
Vitamin B12	Anemia, glossitis and neurological symptoms (numbness, muscle weakness and ataxia)
Vitamin D	Rare osteomalacia, increased risk of mortality
Vitamin E	Reduced antioxidation
Vitamin K	Increased risk of bleeding
Zinc	Hepatocyte dysfunction, increased risk of hepatic encephalopathy
Magnesium	Dysgeusia, increased risk of hepatic encephalopathy

parameters[63]. Weight changes, dietary intake changes, presence of gastrointestinal symptoms, functional capacity and the metabolic demand associated with the disease state are the historical components, while the physical examination components include the presence of edema, ascites, muscle wasting and subcutaneous fat loss. The scale classifies patients from well-nourished to severely malnourished[64]. However, this scale underestimates the presence of sarcopenia and is not a good outcomes predictor[65].

#### **Royal free hospital subjective global assessment**

This is a modified version of the subjective global assessment and includes some objective variables as well like anthropometry and gender of the patient[66].

#### **Assessment of sarcopenia**

**Computed tomography scan:** Computed tomography scan can be utilized to calculate the cross-sectional area of muscles at the L3 vertebral level. The psoas, paraspinial and abdominal wall muscles are used to calculate their skeletal muscle area. The skeletal muscle index is calculated by dividing the skeletal muscle area by the patient height. A value of the skeletal muscle index less than 50 for men and less than 39 for women is considered to meet the criteria for sarcopenia. Computed tomography scan is an expensive tool and not routinely performed but if done for screening of hepatocellular carcinoma, evaluation for liver transplant or vascular shunt can be utilized for assessment of sarcopenia and calculation of the skeletal muscle index[67,68].

**Anthropometry:** Anthropometry as a screening tool for nutritional assessment can prove to be important in resource limited settings. The easiest and least technically challenging is the measure of the BMI using anthropometric measurements. However, the use of BMI as a nutritional assessment tool in patients with advanced liver disease is limited as patients are often in a volume overload state, which affects their body weight[9]. A corrected BMI can be calculated instead after paracentesis of ascitic fluid or by using dry body weight[65,69]. Mid arm muscle circumference is an important alternative measurement and is not reflective of the overall body volume status. Mid arm muscle circumference shows good correlation with body cell mass measurement, which is a proven marker for PCM in CLD patients. Mid arm muscle circumference is related to mortality risk in CLD patients and hence holds prognostic value as well[70]. Skin fold thickness measurement can also be used as a nutritional status assessment tool. Thickness can be measured at the triceps, biceps, subscapular and supra-iliac areas and is representative of fat reserve. It recognizes malnutrition earlier than the BMI[61].

**Dual-energy X-ray absorptiometry scan:** Dual-energy X-ray absorptiometry is a radiological modality that is used to measure bone mass, fat mass and fat free mass, which is representative of lean muscle mass[71]. Its use is limited in cirrhotic patients as fat free mass can also include water mass.

#### **Bioelectrical impedance analysis**

Bioelectrical impedance analysis is a low cost, easy to administer screening tool. Alternating current is applied using two electrodes, and the impedance recorded. This

can be performed at the bedside. Bioelectrical impedance analysis is used to estimate total body water, fat mass and hence fat free mass. However, bioelectrical impedance analysis was shown to underestimate malnutrition status as compared to the PCM score in a study from Pakistan. PCM score is thus calculated using anthropometric measurements and some lab parameters[40].

### **Liver specific tools**

A few specific nutrition screening tools have been developed for liver disease patients and these include the Royal Free Hospital-Nutrition Prioritizing Tool and the Liver Disease Undernutrition Screening Tool. The Royal Free Hospital-Nutrition Prioritizing Tool score includes components involving weight loss, volume overload, BMI and reduced oral intake. Patients are then classified as being at low, moderate or high risk for malnutrition[72]. The Liver Disease Undernutrition Screening Tool includes components of oral intake, weight loss, loss of subcutaneous fat or muscle mass, volume overload and functional status[73,74]. These tools have not been studied in detail in the South Asian Population.

### **Dietary assessment**

A dietary interview with the patient provides important insight to the patient's nutritional status. It recognizes barriers to nutritional intake and any deficiencies that need to be addressed. A thorough evaluation includes number of meals eaten, time between each meal, protein and fluid intake and total calories consumed as well as any nausea, vomiting, diarrhea or constipation. A thorough evaluation takes time and requires trained staff. Additionally, patient factors such as poor recall and lack of cooperation also play a role. A 3 d food diary is the best method for a dietary assessment, but it requires patient cooperation as well as patients being capable of writing and maintaining, which may be difficult in the mostly uneducated population of South Asia. Therefore, repeated short-term 24 h recalls are recommended and may prove to be important in this population[75,76]. Patients should at least be asked if their food intake has changed and by how much over what period of time.

In a study evaluating reasons for food aversion in a Pakistani population, it was concluded that factors such as advice from family doctor, close friends and relatives and alternative medicine practices influenced dietary restrictions in patients with advanced liver disease[77]. Lack of awareness about proper dietary intake was prevalent in both educated and uneducated populations with CLD in this population[78]. Table 2 summarizes the methods of nutritional assessment.

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## **TREATMENT**

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### **General caloric and protein intake**

A multidisciplinary approach for the treatment of malnutrition in liver cirrhosis is important for improving patient survival and long-term outcomes[79]. Nutritional counseling should be included in the patient management. According to the 2020 European Society for Clinical Nutrition and Metabolism guidelines, patients of CLD and a sedentary lifestyle should consume a daily calorie intake of  $1.3 \times \text{REE}$  (Resting Energy Expenditure)[80], where indirect calorimetry has been used to calculate the REE.

Patients with cirrhosis are recommended to consume 3 to 5 meals per day ensuring there are short starvation periods in between. A late evening carbohydrate snack has been shown to improve protein metabolism in cirrhosis by affecting nitrogen balance [81-83]. Patients should have an energy intake of 30-35 kcal/kg per day and a protein intake of 1.2-1.5 g/kg per day, whereas non-malnourished patients are recommended to intake 1.2g/kg per day of protein, and malnourished and sarcopenic patients should consume 1.5 g/kg per day of protein. However, a higher caloric intake is recommended for patients with acute decompensation or conditions with increased energy expenditure. REE should be calculated whenever possible[80]. In patients with HE, there is no recommendation for protein restriction[84-86].

### **Use of BCAA**

In patients who are protein intolerant (develop HE with ingestion of mixed proteins), consumption of BCAA (at the rate of 0.25 g/kg per day) or vegetable derived proteins is recommended[80,87].

**Table 2 Nutritional assessment methods for chronic liver disease**

Nutritional assessment methods	Description
Subjective global assessment (SGA)	Uses components of history and physical exam
Royal free hospital subjective global assessment (RFH-SGA)	Modified version of SGA, includes anthropometry and gender
Sarcopenia assessment	
Computed tomography scan	Used to calculate skeletal muscle area and the skeletal muscle index at the L3 vertebral level
Anthropometry	Mid arm muscle circumference, skin fold thickness, BMI calculation
Dual-energy X-ray absorptiometry	A radiological modality that is used to measure bone mass, fat mass and fat free mass
Bioelectrical impedance analysis	Alternating current is used to estimate total body water, fat mass and fat free mass
Liver specific tools	
Royal Free Hospital-Nutrition Prioritizing Tool	Includes weight loss, volume overload, BMI, and reduced oral intake, classifies patients according to risk of malnutrition
Liver Disease Undernutrition Screening Tool (LDUST)	The LDUST includes components of oral intake, weight loss, loss of subcutaneous fat or muscle mass, volume overload, and functional status
Dietary assessment	Includes dietary review, 3 d food diary, 24 h diet recall

BMI: Body mass index; SGA: Subjective global assessment.

Prescription of long-term BCAA supplement is recommended for patients with advance cirrhosis. Use of BCAA enriched formula has been shown to improve survival in patients with alcoholic steatohepatitis and cirrhosis with an improved mental state in protein intolerant cirrhotic patients with HE[6,88-91]. However, the cost of BCAA supplements needs to be considered when prescribing them to patients.

### **Micronutrients**

In cirrhotic patients, any micronutrient deficiency should be corrected. Micronutrient deficiencies may include both water soluble (especially thiamine) and lipid soluble deficiencies[92,93]. While there are no proven therapeutic effects directly by correcting micronutrient deficiencies, supplementation of zinc and vitamin A may improve dysgeusia and hence nutritional intake and affect the nutritional status indirectly[93, 94]. While zinc deficiency has been associated with HE, supplementation has not shown any significant therapeutic effect on the encephalopathy[95-99]. Practically, a liberal supplementation is recommended in the first 2 wk of therapy, as a diagnosis of a deficiency would be costly and take time[80].

If a low sodium diet is prescribed in the scenario of ascites, the increased risk of lower intake should be considered due to the non-palatability of such a diet[100,101]. Ensuring adequate nutrition intake is important with sodium restriction.

### **Enteral and parenteral nutrition**

If patients are unable to tolerate diet orally or if the nutritional target is unmet with oral nutrition, enteral nutrition (EN) is recommended. An adequate nutrient intake is the primary goal in cirrhotic patients. EN has been proven to be beneficial in survival and liver function[84,89]. However, with EN a risk of overfeeding exists, as the energy intake can exceed the recommended intake.

If the patient is unable to maintain oral and EN, parenteral nutrition (PN) should be used. When administering parenteral nutrition, patients are more prone to infection and sepsis through intravenous lines[25].

## **CONCLUSION**

Malnutrition in liver cirrhosis is a serious problem in South Asia where the etiology differs from the Western population. As malnutrition is generally highly prevalent in the region, it causes an impact on patients with liver cirrhosis. Urgent attention to address malnutrition is needed to improve patient outcomes. Emphasis on assessment for nutritional status at the initial visit with recording of vital signs is needed.

Simultaneously, treating physicians need to be made aware of the misconceptions surrounding nutritional restrictions in cirrhosis so that patient education is done correctly based on proper scientific evidence.

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