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Effect of High Protein BCAA-Enriched Oral Nutrition Supplement (ONS) on Malnutrition in Indian Chronic Liver Disease (CLD) Patients: PROTON Study

Rachana Bhoite[1], Chandan Kumar Kedarisetty[2], Nikhileswar Yandamuri[3], Vinita Satyavrat[1], Sukhada Bhatte[1], Manasa Premasudha Sadananda[1], Arti Sanghavi[1], Rayees Unnisa[1], Sagar Katar[1]

[1]Nutrition Science, Dr Reddy's Laboratories, Banjara Hills, Hyderabad, India
[2]Gleaneagles Global Hospital, Hyderabad, India
[3]Aditya Hospitals, Hyderabad, India
Email: rachanamb@drreddys.com

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Abstract

Background: Chronic liver disease (CLD) is a long-term progressive deterioration of liver functions, leading to fibrosis and cirrhosis. Malnutrition and sarcopenia are common in CLD patients, worsening treatment outcomes and survival rates. This study investigates the impact of an oral nutrition supplement (ONS) on malnutrition in CLD patients. **Materials and Methods:** A multi-centre single-arm, prospective interventional study was conducted with 76 malnourished CLD patients at Gleneagles Global Hospital and Aditya Hospitals, India (approved by institutional ethics committees and CTRI/2023/03/050644). Participants received 2 - 3 servings of scientifically designed high protein Oral Nutritional Supplement (ONS), enriched with BCAAs, and other micronutrients for three months in addition to the daily diet as per ESPEN guidelines. The study assessed changes in nutritional intake, liver enzymes, muscle mass, handgrip strength, and chronic liver disease-related quality of life (CLDQOL). The pre-post data was analyzed using paired t-test at 5% level of significance. **Results:** Post-supplementation, significant improvements were observed in nutritional intake, serum albumin, and liver enzymes {Aspartate Amino Transferase (AST), Alanine Transaminase (ALT)}. Handgrip strength significantly increased, indicating enhanced muscle function. A change in muscle mass was seen in both Bioelectrical Impedance (BIA) and Dual Energy X-ray Absorptiometry (DEXA) scans although the results were not statistically significant. The overall CLDQOL scores as well as individual domain scores like fatigue, emotional function and worry also showed significant improvement

after intervention. The ONS effectively improved protein and BCAA intake, which is crucial for addressing malnutrition in CLD patients. **Conclusion:** Supplementation with high protein BCAA enriched supplement could help improve nutritional status, muscle strength, liver function parameters and quality of life in Indian patients with chronic liver disease. Further research is needed to explore the long-term effects of ONS on CLD progression and patient outcomes.

Keywords

CLD, Chronic Liver Disease, CLDQOL

1. Introduction

Chronic liver disease (CLD) is characterized by progressive worsening of liver function over a period of 6 months, where inflammation of the liver parenchyma results in fibrosis and cirrhosis. As CLD progresses to cirrhosis, the basic functions of the liver, such as the production of clotting factors as well as certain proteins, detoxification of harmful products of metabolism, and excretion of bile, are altered [1]. Chronic liver disease is one of the frequent causes of death, especially in the developing world. An estimated 1.5 billion people have CLD worldwide [1]. The mortality due to CLDs and cirrhosis was around 2.1% of the all-cause mortality as per data from a decade back [2]. There needs to be an integrated approach to improve the outcomes of CLD which needs to take into consideration the physical, mental, psychological and social aspects of CLD.

Malnutrition has been seen to be associated with poor clinical outcomes in CLD where it can lead to serious complications like hepatic encephalopathy and infections and impact quality of life in these patients. National Institute for Health and Clinical Excellence (NICE) recommendations suggests that all patients with CLD be screened for malnutrition at presentation [3]. Malnutrition in chronic liver disease is a result of various factors such as reduced intake, reduced absorption, decreased processing as well as storage of various nutrients and has been seen to be present in around 20% - 50% of patients with compensated cirrhosis and up to 60% of those with advanced disease [4]. As a result of malnutrition, muscle and adipose tissue can be depleted. The loss of muscle tissue can lead to sarcopenia, a surrogate for severe malnutrition which is associated with a higher rate of complications such as susceptibility to infections, hepatic encephalopathy (HE), and ascites, as well as being independent predictors of lower survival in cirrhosis and in patients undergoing liver transplantation [5]. Liver cirrhosis associated with sarcopenia has been shown to have poor prognosis [6]-[12]. Decompensated CLD leads to poor dietary intake; metabolic changes characterized by elevated energy expenditure, reduced glycogen storage, an accelerated starvation response with increased protein catabolism resulting in muscle wasting. Malnutrition is not typically a complication of acute liver injury but manifests with progression to liver failure [13]. There is a marked reduction in circulating branched chain amino acids (BCAAs) as these are

used to produce glucose in patients suffering from CLD. The decrease in BCAAs results in the breakdown of muscle as BCAAs are the preferential energy source of skeletal muscle and muscle tissue [14]. With the decrease in BCAAs there is a consequent increase in aromatic amino acids (AAAs) which is further linked to complications like hepatic encephalopathy, edema, ascites, hypoalbuminemia, insulin resistance, hepatocarcinogenesis, and impaired immune function. A lower serum BCAA/aromatic-amino-acid ratio is associated with a worse prognosis in patients with advanced liver disease [15].

A high-energy, high-protein diet is paramount to managing malnutrition in CLD, and there is a lack of evidence-based guidelines based on interventional studies [16]. PEM is present in approximately 60% of decompensated and 20% of compensated cirrhotic patients [17] ESPEN (European Society for Clinical Nutrition and Metabolism) guidelines recommend a calorie intake of 25 to 30 kcal/kg of body weight per day and a protein intake of 1 to 1.5 grams per kg of body weight per day [18] for better health outcomes in individuals with chronic liver disease whereas in malnourished cirrhotic patients majority of guidelines recommend an intake of 35 - 40 kcal/ kg/day along with a protein intake of 1.2 - 1.5 g/kg/day [19]. It is important to note that high protein diets are a requisite to help reduce the incidence of sarcopenia and to help improve lean body mass, which in turn can reduce fatigue and thus improve the quality of life of people with CLD.

Muscle loss in the CLD needs to be managed by a multipronged strategy involving the dietary intake of adequate energy as well as protein along with micronutrients combined with a structured regular physical activity [9] [20]. In a study conducted on 133 patients with CLD it was seen that malnourished patients had lower health-related quality of life (HRQOL) and they reported increased nutrition impact symptoms (NIS) like pain, poor appetite, dysgeusia and early satiety [21].

The PROTONS [Protein enriched Oral Nutrition Supplement on improving Nutrition] study aimed and understand the effect of a scientifically designed nutritional supplement high in protein, enriched with BCAAs, along with carbohydrate, fats, and micronutrients on liver enzymes, muscle mass, handgrip strength and health related quality of life.

2. Methodology

2.1. Study Design and Subjects

The study was a single-arm, multi-centre prospective study with 76 participants who were malnourished with clinically diagnosed CLD. The participants for the study were patients with Chronic Liver Disease and were recruited from the patients that visited the gastroenterology department of Gleaneagles Global Hospital, and Aditya Multispecialty Hospital, Hyderabad, Telangana.

Patients with compensated CLD, hepatocellular carcinoma (HCC), hepatic encephalopathy less than grade 3, alcoholic liver diseases, and patients awaiting liver transplantation with CLD were included in this study. Patients who had allergies or contraindications to protein, milk, nuts, or any of the ingredients of the nutri-

tional supplement, presence of any cancer except HCC, who were treated with albumin therapy in the past one year before enrollment, patients with creatinine more than 1.5 mg and patients with no clinical evidence of infection and women who are either pregnant or lactating were excluded from the study. Written informed consent was obtained from all subjects.

2.2. Study Objectives

The objective of the study was to evaluate the effect of a scientifically designed high protein, BCAA enriched oral nutritional supplementation (ONS) on the nutritional status of patients with CLD, and liver parameters after 3 months of supplementation.

2.3. Study Tools

The study looked at changes in liver enzymes (AST, ALT) and their ratio (AST/ALT) as the primary outcome of the study. The secondary outcomes were improvement in dietary intake using a 24 hour dietary recall, change in body composition as assessed by bioelectrical impendence (BIA) using Actofit SmartScae Pro Max and Jawon IOI353 as well as DEXA scan, using the Spellman Prodigy 7681 model, changes in other liver enzymes like GGT, changes in lipid profiles, change in plasma glucose as well as insulin estimated by a combined measure of homeostatic model assessment (HOMA), changes in hand grip strength as measured by a hand dynamometer and change in quality-of-life indicators as assessed using Chronic liver disease questionnaire (CLDQ). The CLDQ is a short, easy to administer quality of lite questionnaire that correlates with the severity of the liver disease. It comprises 29 questions spread across 6 domains viz., abdominal symptoms, fatigue, systemic symptoms, activity, emotional function and worry along with an overall CLDQ score. [22] The Royal Free Hospital Global Assessment Scheme (RFH-GA) uses BMI, mid-arm muscle circumference (MAMC) and dietary intake to screen for the risk for malnutrition [23].

2.4. Interventional Product

The participants were advised to consumed 2 - 3 servings of the high protein-BCAA enriched ONS (**Table 1**) in addition to a standard diet for a period of 12 weeks. The duration of supplementation was chosen considering the budget constraints. Longer duration studies may help understand the long-term impact of ONS on muscle function and disease outcomes in patients with CLD.

2.5. Ethical Considerations

The study followed the ethical guidelines of the 1975 Declaration of Helsinki and was approved by the institutional ethics committees of the 2 participating hospitals. The clinical trial was prospectively registered with the Clinical Trial Registry of India (CTRI/2023/03/050644) which is further registered with the International Clinical Trial Registry Platform of the WHO [24].

Table 1. Approximate composition of intervention product (High Protein-BCAA enriched ONS).

Nutrients	Unit	~ Per One Serve
Energy	kcal	121
Protein	g	13.8
Carbohydrate	g	9.6
Total Fat	g	3
Sodium	mg	70.8
VITAMINS		
Vitamin C	mg	12
Vitamin B5	mg	1.5
Vitamin E	mg	3
Vitamin B6	mg	0.42
Vitamin B2	mg	0.48
Vitamin B1	mg	0.42
Vitamin B3	mg	3
Vitamin A	mcg	90
Folic acid	mcg	49.2
Vitamin K	mcg	18.3
Biotin	mcg	7.2
Vitamin D	mcg	1.5
MINERALS		
Magnesium	mg	27.6
Iron	mg	2.1
Zinc	mg	1.59
Selenium	mcg	4.8
Calcium	mg	90
Phosphorous	mg	90
BRANCHED CHAIN AMINO ACIDS		
Leucine	g	1.5
Isoleucine	g	1.29
Valine	g	1.5
OTHER NUTRIENTS		
Lysine	g	0.75
Threonine	g	0.675
L-Taurine	mg	14.4
L-Carnitine	mg	14.4

Note: ~ Indicates approximately.

2.6. Statistical Methods

The sample size of the study was calculated considering the change in the primary outcome i.e. the change in AST/ALT into consideration to detect a change of 20% with a power of 80%. The sample size calculated was 63 further, considering about 20% dropouts in the study, 76 subjects were enrolled into the study. Normality testing was done using the Shapiro-Wilk test for normal distribution. A "p" value of <0.05 indicates failure of normal distribution. Normally distributed data was presented as a mean and standard deviation; non-normally distributed data was presented as medians quartiles (interquartile range).

3. Results and Discussion

3.1. Results

A total of 76 malnourished Indian patients with chronic liver disease (CLD) were enrolled in the study. The participants were adults above the age of 18 years to 65 years of age, the demographics of which are in Table 2(A). The number of participants enrolled for the study was 76 out of which 72 completed the study (Table 2(B)). The patients had a median age of 42.5 years [Mean ± SD: 44.6 ± 9.43)]; 76% were males, and 24% were females.

Table 2. (A) Summary of demographic characteristics; (B) Participant disposition in the study (Enrolled Population).

(A)		
Baseline Characteristics (N = 76)	Mean (SD)	Median (IQR)
Age (Years)	44.6 (9.43)	42.5 (13.5)
Male, N (%)	58 (76)	
Female, N (%)	18 (24)	
Height, cm	167.05 (9.3)	168.00 (15)
Weight, kg	65.54 (15.16)	65.00 (20.9)
BMI, kg/m^2	23.38 (4.91)	22.40 (7.8)
Abbreviations: N = Number of patients SD = Standard Deviation; Min = Minimum; Max = Maximum; IQR= Interquartile Range.		
(B)		
Enrolled Population: Number of patients who provided informed consent		76
Total no. of patients completed the study, n (%)		72 (94.74)
Total no. of patients discontinued the study, n (%)		4 (5.26)
Withdrawal of consent by Subject		0
Screen Failure		0
Violation of Eligibility Criteria		0

Continued

Entry into interventional study	0
Lost to follow-up	0
Patient's decision, n (%)	4 (5.26)

76 (100%) patients had at least one medical/surgical history. Most of the patients had hepatobiliary disorder, which includes liver disorder (98.68%), portal hypertension (42.11%), jaundice (17.11%), hepatomegaly (2.63%), and hepatitis (1.32%). Another prevalent medical condition in the study patients was hypertension (7.89%). The frequency of the rest of the medical history/surgical conditions was <5%.

Among the enrolled population, 58% were classified as high-risk malnutrition patients, while 18% were classified as moderate risk, and 24% were classified as low-risk patients on the Royal Free Hospital Global Assessment Scheme (RFH-GA) (Figure 1). There was no sub-group analysis to evaluate any differential effects based on baseline malnutrition status due to the limitations of a small sample size.

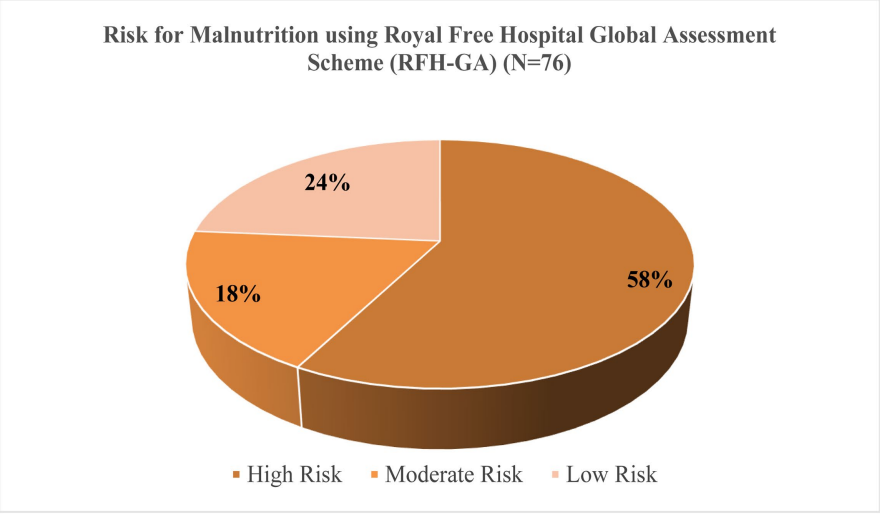

Figure 1. Risk for malnutrition using royal free hospital global assessment scheme (RFH-GA).

Following 12 weeks of supplementation of 2 - 3 servings of the high protein and BCAA-enriched oral nutritional supplement (ONS) (Table 1), there was marked improvement seen in the liver enzymes compared to the baseline (Table 3). A significant decline was seen in aspartate aminotransferase-AST, alanine aminotransferase-ALT, and AST/ALT ratios compared to the baseline. There was a decrease in the levels of gamma-glutamyl transpeptidase-GGT as well as alkaline phosphatase but were not statistically significant. A significant decline in total bilirubin levels was also observed.

Table 3. Summary of biochemical parameters.

Parameter	Baseline (Mean ± SD)	Week 12 (Mean ± SD)	Change from Baseline (Mean ± SD)	P-value
Liver Function Biomarkers				
Gamma-Glutamyl Transpeptidase (GGT)	57.62 ± 87.07	38.75 ± 18.58	−18.87 ± 79.98	0.056
Aspartate Aminotransferase (AST)	42.27 ± 20.40	35.62 ± 11.11	−6.642 ± 17.40	0.002*
Alanine Aminotransferase (ALT)	34.7 ± 14.53	31.3 ± 9.87	−3.5 ± 11.56	0.013*
AST/ALT Ratio	1.5 ± 0.83	1.31 ± 0.70	−0.19 ± 0.55	0.004*
Alkaline Phosphatase (ALP)	119.0 ± 33.73	113.3 ± 29.72	−5.7 ± 28.37	0.099
Total Bilirubin (mg/dL)	2.63 ± 3.54	1.67 ± 2.42	−0.96 ± 2.53	0.002*
S. Albumin	3.71 ±0.727	3.91± 0.651	0.20 ± 0.64	0.009*
Lipid Profile and Renal Function Tests				
Serum Creatinine (mg/dL)	0.87 ± 0.207	0.88 ± 0.184	0.01 ± 0.181	0.559
Serum Sodium (mmol/L)	137.6 ± 5.56	138.8 ± 3.14	1.0 ± 6.20	0.193
Total Cholesterol (mg/dL)	161.5 2± 48.47	170.3 ± 43.26	8.3 ± 29.99	0.021*
HDL-C (mg/dL)	45.2 ± 14.68	53.3 ± 14.88	8.3 ± 29.99	0.0023*
LDL-C (mg/dL)	96.42 ± 51.230	95.75 ± 46.18	−0.85 ± 65.66	0.9133
Triglycerides (mg/dL)	132.2 ± 79.87	125.9 ± 55.56	−9.7 ± 68.93	0.2367
Handgrip Strength (Dominant Hand)				
Handgrip Strength (kg)	26.29 ± 6.91	27.16 ± 6.70	0.87 ± 3.23	0.0298*

A 24-hour dietary recall was taken at 4 end points (bassline, week 4, week 8 and week 12) and the energy and macronutrient intake was computed with the help of a qualified dietitian. At baseline, subject's habitual intake was measured using the 24-hour dietary recall. Subjects were asked to continue with their usual dietary intake. Adherence to the supplement was monitored by evaluating the subject diary record and collecting empty sachets or unused products during every visit. More than 80% compliance with the supplement was seen in 98.7% of the subjects. A significant improvement was observed in nutritional intake from baseline at week 4, week 8, and week 12 following supplementation with ONS. The mean change in energy intake from baseline was 243 ± 383 ($p < 0.0001$) at week 4, 247 ± 310 ($p < 0.0001$) at week 8, and 189 ± 389 ($p = 0.0001$) at week 12, indicating a statistically significant increase in energy intake from baseline. Similarly, the mean change in carbohydrate intake was 14.023 ± 50.93 ($p = 0.0223$) at week 4, 14.732 ± 41.84 ($p = 0.0039$) at week 8, and 8.27 ± 49.70 ($p = 0.1622$) at week 12, indicating a significant increase in carbohydrate intake until week 8 but not beyond. The mean change in protein from baseline to week 4, week 8, and week 12 was [31.93

± 23.92 ($p < 0.0001$)], [35.51 ± 17.18 ($p < 0.0001$)], and [24.46 ± 24.90 ($p < 0.0001$)], respectively, demonstrating a significant increase protein intake till the end of the study. Total fat intake increased significantly from baseline to week 12; the mean change in total fat from baseline was 6.79 ± 18.54 ($p = 0.0027$) at week 4, 5.39 ± 15.82 ($p = 0.0051$) at week 8, and 6.57 ± 18.82 ($p = 0.0041$) at week 12. Total fiber intake remained unchanged from baseline to week 12 following supplementation with the ONS. The mean change in total fiber intake from baseline was −0.08 ± 10.14 ($p = 0.9475$) at week 4, −1.23 ± 9.28 ($p = 0.2635$) at week 8, and −0.37 ± 9.82 ($p = 0.7529$) at week 12.

The lipid profile (Table 3) of participants enrolled in the study, showed a significant increase in total cholesterol levels, with a significant increase in HDL-C in comparison to the baseline. This is possibly due to improved protein and micronutrient intake. No significant changes were observed in the levels of LDL-C and triglycerides after 12 weeks of supplementation. Body compositions were assessed by Bioelectrical Impedance analysis and DEXA scan which showed a significant improvement in a significant increase in normal bone density/bone mass but there were no significant changes, visceral fat, or any other parameter after supplementation. The renal function tests like serum creatinine, blood urea and serum sodium levels remained unchanged after 12 weeks of ONS supplementation. There was a significant increase in handgrip strength of the dominant hand seen after 12 weeks of supplementation (Table 3). A positive change was seen in muscle mass, but it was statistically insignificant. Improvement in protein intake, may have led to improved hand grip strength. However, further studies could incorporate exercise to see an overall impact of protein and exercise on improved muscle function in patients with CLD. The CLDQ questionnaire showed an improvement in overall Quality of Life (Table 4). The domain-wise sub-scores for fatigue, emotional function, and worry improved significantly. The scores of abdominal symptoms, systemic symptoms and activity did not change significantly following ONS.

Table 4. Change in chronic liver disease questionnaire (CLDQ).

Parameter	Baseline Mean (SD)	Week 12 Mean (SD)	Change (SD)	P-value
Abdominal Symptoms	3.93 (1.03	4.00 (0.85)	0.07 (1.42)	0.6920
Fatigue	3.48 (0.70)	3.82 (0.85)	0.34 (0.90)	0.0022*
Systemic Symptoms	3.82 (0.97)	4.03 (0.90)	0.21 (1.34)	0.1865
Activity	3.61 (0.74)	3.76 (0.72)	0.15 (0.91)	0.1538
Emotional Function	3.63 (0.72)	4.00 (0.84)	0.37 (1.11)	0.0055
Worry	3.74 (0.91)	4.13 (1.00)	0.39 (1.44)	0.0247*
Overall CLDQ	3.68 (0.69)	3.96 (0.76)	0.27 (1.04)	0.0286*

3.2. Discussion

The primary outcome of the study was to look at the effect of the supplementation

on liver enzymes, AST, ALT and the ratio between AST and ALT (AST/ALT). As there is inflammation and destruction of liver cells in CLD there is an increased release of aspartate aminotransferase (AST) and alanine aminotransferase (ALT) which reflects as high levels of these enzymes in the blood. AST and ALT can be increased to two to three times of their normal limits although normal levels may still be present in cirrhosis [25]. Bilirubin levels, alkaline phosphatase (ALP) and GGT may also increase in cholestatic conditions. This study saw that with supplementation with ONS there was a significant decrease in AST, ALT as well as AST/ALT and bilirubin. There was a decrease in the ALP and GGT but did not achieve significance. A decrease in the liver enzyme levels suggests improved liver health following ONS. Similarly, a decline in AST/ALT and bilirubin levels also suggests a positive effect of ONS with a potential reduction in disease progression and improved liver function.

There is a decrease in hepatocellular function in cirrhosis or even CLD, which causes a reduction in serum albumin levels. Albumin administration on a long-term basis in patient with decompensated cirrhosis has been shown to reduce mortality (increase long term survival) as well as to reduce incidence and help manage complications like ascites [26] [27]. It has been noted that increase in serum albumin levels in patients with liver cirrhosis increase the survival rate [28]. This study demonstrated the effect of improved nutrition on the improvement of albumin levels in patients with CLD. No changes in the levels of serum creatinine or sodium levels were seen after 12 weeks of supplementation, suggesting that renal functions remained stable after the intervention.

Sarcopenia is a condition where there is a progressive as well as systemic loss of both skeletal muscle mass and physical strength. Other than ageing, cirrhosis of the liver is a cause of secondary sarcopenia [29]. Sarcopenia has been seen to be a common complication of CLD and the decrease in grip strength was seen to be a most prominent association with the progression of sarcopenia in cirrhosis of the liver [30]. Handgrip strength is a good measure of assessing muscle function [31]. One of the outcomes of this study was to measure hand grip strength in response to supplementation of ONS for 12 weeks to the participants. There was a significant increase in handgrip strength of the dominant hand after 12 weeks of supplementation with ONS thus indicating that proper supplementation with a combination of the right micro and macronutrients not only helped preserve muscle function but can also potentially increase the same. Positive changes were seen in body composition; however, it was a short period to see any significant changes. Coupled with weight bearing exercise, supplementation with BCAA enriched protein ONS may help combat sarcopenia in patients with CLD.

One of the reasons for malnutrition in CLD as mentioned earlier in this paper is poor dietary intake of food besides several other causes. Anorexia as well as symptoms of liver decompensation led to poor dietary intake which can further aggravate CLD [3]. In this study, dietary intake was evaluated by 24-hour dietary recall. Supplementation with ONS showed a significant improvement in nutri-

tional intake from baseline. This indicates the potential of ONS in addressing nutritional deficiencies, improving liver health, and potentially improving outcomes in CLD patients.

CLD is a progressive disease and is a major cause of mortality and morbidity, thus patients with CLD experience a myriad of symptoms that affect their CLDQOL). Interventions for CLD should also be aimed at helping patients feel better by improving their quality of life. The chronic liver disease questionnaire (CLDQ) is a questionnaire that was designed to find out about the wellbeing of patients with CLD during the past 2 weeks. CLDQ correlates with the severity of liver disease, making it a useful tool for assessing health-related quality of life (HRQL) in patients with chronic liver disease [22]. The improvement in CLDQ scores as well as it's individual parameters like fatigue, emotional function, and worry, with the supplementation indicated the role of good nutrition in helping patients with CLD lead a better quality of life which is an important subjective aspect in overall management of CLD. The study used a pre-post design in a real-world setting. The limitation of the study was that it did not include the control group due to ethical concerns of withholding nutrition intervention, which may limit the generalizability of the findings. Further studies with a control group may help validate our findings further.

4. Conclusion

A high protein, BCAA-enriched oral nutrition supplementation helps improve the nutritional status of CLD patients. The supplementation has reduced malnutrition, liver function biomarkers and improved body composition, muscle strength, handgrip strength and quality of life in patients with CLD. Therefore, addition of BCAA-enriched high-protein oral nutrition supplementation in the diet of patients with CLD may help in the management of malnutrition and its consequences.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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Abbreviations and Acronyms

BCAA	Branched Chain Amino Acids
ONS	Oral Nutrition Supplement
CLD	Chronic Liver Disease
PROTONS study	Protein enriched Oral Nutrition Supplement on improving Nutrition
CLDQOL	Chronic Liver Disease Related Quality of Life
AST	Aspartate Amino Transferase
ALT	Alanine Transaminase
BIA	Bioelectrical Impedance
DEXA	Dual Energy X-ray Absorptiometry
AAA	aromatic amino acids
PEM	Protein Energy Malnutrition
ESPEN	European Society for Enteral and Parenteral Nutrition
HRQOL	Health Related Quality of Life
NIS	Nutrition Impact Symptoms
GGT	Gamma-Glutamyl Transpeptidase
ALP	Alkaline Phosphatase
RFH-GA	Royal Free Hospital Global Assessment Scheme
MAMC	Mid Arm Muscle Circumference
HCC	Hepatocellular Carcinoma
SD	Standard Deviation
IQR	Interquartile Range
HDL-C	High Density Lipoprotein C
LDL-C	Low Density Lipoprotein C