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ORIGINAL RESEARCH

Anthropometric measurements, nutritional status, and diet quality of cirrhosis patients: Comparison of two etiologies

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Highlights & Insights

- **Scientific Gap:** Data comparing nutritional status, anthropometric measures, and diet quality across different cirrhosis etiologies are limited.
- **Key Finding:** Diet quality did not differ by etiology, while higher NRS-2002 scores were associated with greater cirrhosis severity.
- **Clinical Impact:** Nutritional risk screening and etiology-specific assessment may support individualized nutritional management in patients with cirrhosis.

ABSTRACT

Background and Aim: This study aimed to compare anthropometric measurements, nutritional status, and diet quality between two etiologic groups of patients with cirrhosis.

Materials and Methods: This study was conducted with 60 patients (30 women–30 men) with non-alcoholic fatty liver disease (NAFLD) and hepatitis B-C who were followed up in a university hospital in Ankara between February and May 2024. A questionnaire was administered to determine sociodemographic characteristics and disease-related information. Child-Turcotte-Pugh (CTP) and nutritional risk screening (NRS-2002) scores were calculated. Height, body weight, middle arm circumference, triceps skinfold thickness, and handgrip strength were measured. Nutritional status was evaluated using a 3-day food record, and diet quality index-international (DQI-I) was used to assess diet quality.

Results: The mean age of the participants was 58.6±7.27 years. After Bonferroni correction, body mass index was significantly higher among women with NAFLD than among women with hepatitis B/C ($p=0.004$), whereas left handgrip strength was significantly higher among men with hepatitis B/C than among men with NAFLD ($p=0.003$). After Bonferroni correction, the total DQI-I score did not differ significantly between the NAFLD and hepatitis B/C groups. A positive correlation was found between CTP and NRS-2002 scores ($r=0.607$, $p<0.001$). Regression analysis showed that DQI-I score was not a significant predictor of CTP score, whereas NRS-2002 score was a significant positive predictor in both disease subgroups and the overall study population.

Conclusion: Diet quality assessed by DQI-I was not significantly different between patients with NAFLD and hepatitis B/C cirrhosis after Bonferroni correction. Nutritional status and body composition parameters should be evaluated considering the etiology of cirrhosis.

Keywords: Cirrhosis, nutritional status, quality of diet.

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Introduction

Cirrhosis is one of the important causes of morbidity and mortality all over the world and is the final stage of chronic liver diseases, in which normal liver cells are damaged and replaced by connective tissue.[1] Liver cirrhosis is a progressive disease that occurs as a result of the deterioration and change of the morphological structure of the liver, commonly with hepatocellular necrosis, increase in connective tissue, hepatic regeneration, nodular formation, and increased fibrous tissue.[2]

The etiology of cirrhosis varies geographically; alcoholism, hepatitis C virus (HCV) infection, and non-alcoholic fatty liver disease (NAFLD) are the most common causes in western countries, while in the Asia-Pacific region, hepatitis B virus (HBV) infection is the primary cause of liver cirrhosis. Some cases are idiopathic or cryptogenic.[3] However, the past decade has seen major changes in the etiology and burden of liver disease. Increasing HBV vaccination coverage and better availability of antivirals effective against HBV have led to reduced mortality rates from HBV-associated cirrhosis.[4]

15–30% of cirrhotic patients are hypermetabolic and have a resting energy expenditure (REE) above 120%, which negatively affects nutritional status.[5] Disease-induced inflammation appears to be a contributing factor to hypermetabolism and malnutrition, as well as increased beta-adrenergic activity.[6,7] Also in liver cirrhosis, food consumption is difficult due to ascites and anorexia, so energy requirements vary among patients with cirrhosis. Individuals with cirrhosis often have increased energy and protein requirements due to metabolic disorders that include hypercatabolism and increased proteolysis.[8] Deficiency of fat-soluble vitamins is common in liver cirrhosis, especially in patients with cholestasis due to inadequate supply of bile acid. Other reasons for the development of fat-soluble vitamin deficiencies include decreased adequate oral intake, malabsorption, and decreased synthesis of carrier and transfer proteins such as retinol-binding protein.[9] In patients with liver cirrhosis, especially zinc, magnesium, and Vitamin A levels being within normal limits have a positive effect on the sense of taste and, therefore, can indirectly improve nutritional status by increasing food intake.[10,11]

This study aimed to compare anthropometric measurements, nutritional status, and diet quality of cirrhosis patients with different two etiologies.

Material and Methods

Participants and Procedure

This study included 60 inpatients and outpatients with NAFLD or HBV/HCV-related chronic liver disease who were treated or followed at the Department of Gastroenterology of a university hospital in Ankara between February and May 2024. Assuming an effect size of Cohen's d = 0.78, equal allocation between groups (1:1), a two-sided significance level (α) of 0.05, and a statistical power of 84%, the required total sample size was calculated as 60 participants (30 per group) using G*Power for a two-tailed independent-samples t-test. The study groups consisted of 28 patients with NAFLD and 32 patients with chronic hepatitis B or C. Hepatitis B and C patients were combined into a single group because both conditions belong to the chronic viral hepatitis spectrum and share similar pathophysiological mechanisms, including hepatic inflammation and fibrosis. NAFLD-related cirrhosis was diagnosed based on clinical evaluation supported by imaging findings (ultrasonography and/or elastography) and laboratory data, in the absence of other causes of chronic liver disease. Alcohol-related liver disease was excluded based on detailed patient history and reported alcohol consumption below established threshold levels. Information regarding antiviral treatment status in HBV/HCV patients (treatment-naive or receiving therapy) was recorded and considered in the analysis. Patients aged 24–64 years with a diagnosis of cirrhosis of at least 1 year were included in the study. Patients with other etiologies of cirrhosis (e.g., alcohol-related liver disease), individuals older than 64 years, and pregnant or breastfeeding women were excluded from the study. Anthropometric measurements were obtained using standard procedures. The study was conducted in accordance with the Declaration of Helsinki and approved by the Baskent University Institutional Review Board and Ethics Committee (Project No: 22/519; Date: January 18, 2023).

Disease Severity

Patients' Child-Turcotte-Pugh (CTP) score was calculated by a gastroenterologist to determine the severity of cirrhosis. CTP score was calculated using prothrombin time, albumin, bilirubin, and clinical findings of ascites and encephalopathy. CTP score was stratified as class A (5–6), B (7–9), and C (10–15).[12] The biochemical parameters to be used in calculating the disease severity of individuals were taken digitally from the patient records belonging to the patients' protocol numbers.

Anthropometric Measurements

Patients' body weight (kg) and height (cm) were measured and body mass index (BMI) was calculated. Triceps skinfold thickness (TSF) (mm), middle arm circumference (MUAC), and handgrip strength were measured. The MUAC was measured at the center point of the connecting line between the shoulder and the upper end of the ulna. TSF was measured to the nearest 0.1 mm using Holtain Skinfold Calipers. Patients' TSF and MUAC measurement values were used in appropriate formulas and middle arm muscle circumference (MAMC), midarm muscle area and mid-arm fat area (MAFA) values were calculated.[13]

HGS data were obtained with a Jamar Plus + Digital Hand Dynamometer (Sammons Preston, Bolingbrook, Illinois, USA) calibrated by the manufacturer, with a resolution of 0.1 kgf. Measurements were carried out with the subject seated, shoulders adducted and neutrally rotated, elbow flexed at 90°, forearm in neutral, and wrist between 0 and 30° of dorsiflexion.[14] Each participant performed three measurements with 1-min pauses in between, then the mean of the three measurements was calculated.

Nutritional Status and Nutritional Risk Screening (NRS)

In the study, a survey form was applied to determine the sociodemographic characteristics, nutrition, and disease status of the patients. The nutritional status of the patients was determined by a 3-day food consumption record. BeBiS nutrition information system (BeBiS 7.0, Ebispro for Windows, Stuttgart, Germany, Turkish Version) was used to determine the energy and macro and micronutrient intakes.

NRS-2002 was used as a malnutrition screening tool. It is a screening test consisting of two steps. The first stage is the initial screening. At this stage, participants are asked whether their BMI value is below 20.5 kg/m^2, whether there has been any weight loss in the last 3 months, whether there was a decrease in food intake in the week before the scan, and whether they have a serious illness. If the answer to any of these questions is yes, the second stage is started. The second step screening of NRS-2002 is the final screening and scoring is done at this stage. The final screening consists of two parts: "Nutritional status" and "disease severity." In the first part of the final screening, nutrition is evaluated and BMI, percentage of recent weight loss, and the ratio of food intake in the week before the scan to food intake in normal times are questioned. In the second part of the final screening, the severity of the disease is questioned. In the NRS-2002 evaluation, scores given to the nutritional status and disease severity sections are collected. One is added to the scores of patients aged 70 and over and the total score is created in this way. In this study, this score was not added because individuals over the age of 64 were not included in the study. Patients with a total score ≥3 are at risk of malnutrition; patients with a total score <3 were considered to have no risk of malnutrition.[15,16] The NRS-2002 score was calculated by a dietitian.

Diet Quality

It is a summary measure of dietary quality representing four categories of the diet, including variety, adequacy, moderation, and overall balance. The overall DQI-I score constitutes the sum of the scores for each of these four categories and ranges from 0 to 100 (where 0=The poorest and 100=The highest dietary quality). Dietary variety (score 0–20) captures diversity in food choices and protein sources. Dietary adequacy (score 0–40) captures the adequate intake of food groups and nutrients (vegetables, fruit, grains, fibers, proteins, Fe, Ca, and Vitamin C). Dietary moderation (score 0–30) is scored on the basis of intake of total fat, saturated fat, cholesterol, Na, and empty calorie foods. Finally, overall balance (score 0–10) captures the proportion of energy from carbohydrates, protein and fat, as well as the fatty acid composition, according to accepted general guidelines for the proportion of energy from carbohydrate, protein, fat, and fat composition.[17]

Statistical Analysis

Descriptive statistics were presented according to data type. Categorical variables were expressed as number (n) and percentage (%), while continuous variables were expressed as mean ± standard deviation (SD). The normality of continuous variables was assessed using the Shapiro–Wilk test. For comparisons between two groups, the independent-samples t-test was used for normally distributed continuous variables, whereas the Mann–Whitney U-test was used for non-normally distributed continuous variables. The relationships between categorical variables were analyzed using the Pearson Chi-square test or Fisher's exact test when expected cell counts were <5. Correlations between continuous variables were evaluated using Spearman's correlation analysis due to non-normal distribution. Univariate regression analyses were performed to investigate the association between CTP scores and diet quality and NRS-2002. Statistical analyses were conducted using IBM Statistical Package for the Social Sciences Statistics for Windows, Version 25.0 (IBM Corp., Armonk, NY, USA). $p<0.05$ was considered statistically significant.

Results

A total of 60 adults, including 30 women (50.0%) and 30 men (50.0%), who were treated or followed at the Department of Gastroenterology participated in the study. The mean age of the individuals was 58.6±7.27 years. It was determined that 73.3% of the women and 80.0% of the men who participated in the research were married (Table 1).

Among the patients with viral hepatitis-related cirrhosis, 29 patients had HBV infection, whereas three patients had HCV infection (unshown data). The mean and SD values of individuals' cirrhosis diagnosis time were found to be 4.8±4.43 years in the NAFLD group, while it was 10.3±12.07 years for individuals in the hepatitis B-C group. Diabetes was present in 24 patients (40.0%). No statistically significant differences were observed in cirrhosis-related symptoms according to disease etiology (all $p>0.05$). Antiviral medication use was observed exclusively in the HBV/HCV group (21/32, 65.6%), whereas none of the patients in the NAFLD group received antiviral therapy (0/28, 0.0%; $p<0.001$) (Table 2). Of the 21 patients who received antiviral therapy, 20 had HBV-related cirrhosis and one had HCV-related cirrhosis (data not shown).

The mean and SD of anthropometric measurements of individuals according to gender and etiology are shown in Table 3. After multiple comparison correction, no statistically significant differences were observed in most anthropometric parameters between groups. After Bonferroni correction, BMI was significantly higher among women with NAFLD than among women with hepatitis B/C ($p=0.004$), whereas left handgrip strength was significantly higher among men with hepatitis B/C than among men with NAFLD ($p=0.003$).

Energy, macronutrient and micronutrient intake mean and SD values according to gender and etiology are given Table 4. After multiple comparison correction, no statistically significant differences were found between patients with NAFLD and viral hepatitis-related cirrhosis in terms of energy intake, macronutrient distribution, and micronutrient intake.

Before Bonferroni correction, the NAFLD group appeared to have significantly lower scores for variety, overall food group variety, vegetable group, and total DQI-I score compared with the hepatitis B/C group. However, after applying a Bonferroni-adjusted significance

Table 1. Socio-demographic characteristics

Demographics	Women (n=30)		Men (n=30)		Total (n=60)		p
	n	%	n	%	N	%	
Age (year) (Mean±SD)	59.0±5.94		58.2±8.48		58.6±7.27		0.958
Age (year)							0.261
20–29	–	–	1	3.3	1	1.7	
30–39	–	–	–	–	–	–	
40–49	4	13.3	1	3.3	5	8.3	
50–59	9	30.0	13	43.3	22	36.7	
60–64	17	56.7	15	50.0	32	53.3	
Educational status							<0.001
Primary school	23	76.7	8	26.7	31	51.7	
Middle school	4	13.3	6	20.0	10	16.7	
High school	1	3.3	11	36.7	12	20.0	
University	2	6.7	5	16.7	7	11.7	
Marital status							0.542
Married	22	73.3	24	80.0	46	76.7	
Single	8	26.7	6	20.0	14	23.3	

SD: Standard deviation.

threshold of p<0.0023 for 22 comparisons, none of these differences remained statistically significant (Table 5).

The correlation between CTP score, NRS-2002, and DQI-I values is given in Table 6. It was found that there was a positive correlation between CTP and NRS-2002 (r=0.607, p<0.001). There was a negative correlation between CTP and DQI-I (r=-0.328, p=0.010).

Separate simple linear regression analyses were performed to examine the associations of DQI-I and NRS-2002 scores with CTP score (Table 7). DQI-I score was not significantly associated with CTP score in the NAFLD group, the hepatitis B/C group, or the overall study population (all p>0.05). In contrast, higher NRS-2002 scores were significantly associated with higher CTP scores across all analyses. In the NAFLD group, NRS-2002 score explained 23.1% of the variance in CTP score (R^2=0.231, B=0.944, p=0.010). In the hepatitis B/C group, it explained 46.3% of the variance (R^2=0.463, B=1.724, p<0.001), and in the overall study population, it explained 34.0% of the variance in CTP score (R^2=0.340, B=1.325, p<0.001) (Table 7).

Discussion

Liver cirrhosis is the common pathological consequence of liver damage resulting from a wide variety of chronic liver diseases. Nutritional deficiencies in these patients are associated with increased complications and mortality rates. This exploratory cross-sectional single-center study was conducted to compare the anthropometric measurements, nutritional status, disease severity, and diet quality of 60 patients with cirrhosis of different etiologies.

Clinical conditions and pathophysiological mechanisms contributing to malnutrition in cirrhosis are complex and interrelated. Therefore, especially as liver disease progresses, malnutrition is an important condition to manage effectively.[18] In cirrhotic patients, body weight is not used as an accurate measure of malnutrition due to ascites and edema caused by extracellular fluid accumulation. Before Bonferroni correction, several anthropometric parameters, including body weight, BMI, MAMC, and MAFA, differed according to gender and etiology. However, after Bonferroni correction, only BMI in women and left handgrip strength in men remained statistically significant. It should also be acknowledged that the observed differences in anthropometric and nutritional parameters may be substantially influenced by the significant differences in BMI between the etiological groups, rather than reflecting etiology-specific effects alone.

TSF measurement is useful to estimate subcutaneous adipose tissue and MAMC measurement is useful to estimate skeletal muscle mass in patients with ascites and edema.[19,20] Given the limited health resources of public hospitals in low- and middle-income countries, the MUAC value is an accessible, rapid, and inexpensive measurement and can be easily performed at the bedside in cirrhotic patients with edema and ascites.[21] Uncorrected analyses showed some differences in selected anthropometric measurements; however, these differences did not retain their significance after Bonferroni correction. These findings should be interpreted cautiously given the exploratory design and limited sample size.

The mean handgrip strength value was 17.6±3.1 kg in the group of healthy controls, 16.9±5.2 kg in hepatitis patients and 11.6±4.8 kg in cirrhosis patients, and this value was statistically significantly lower

Table 2. Disease information

Disease information	NAFLD (n=28)		Hepatitis B-C (n=32)		Total (n=60)		p
	n	%	n	%	n	%	
Diagnosis time (years)							0.151[a]
0-5	21	75.0	16	50.0	37	61.6	
6-10	2	7.1	5	15.6	7	11.7	
>10	5	17.9	11	34.4	16	26.7	
Mean±SD	4.8±4.43		10.3±12.07		7.7±9.65		0.082[d]
Chronic disease status							0.129[b]
Yes	21	75.0	18	56.3	39	65.0	
No	7	25.0	14	43.7	21	35.0	
Presence of chronic disease[§]							
Hypertension	11	39.3	7	21.9	18	30.0	0.142[b]
Diabetes mellitus	14	50.0	10	31.3	24	40.0	0.139[b]
Cardiovascular diseases	5	17.9	3	9.4	8	13.3	0.454[a]
Others (Gastrointestinal system diseases, anemia, bone diseases)	7	25.0	3	9.4	10	16.7	0.165[a]
Symptoms[§]							
Weakness, fatigue, lassitude	23	82.1	27	84.4	50	83.3	1.000[b]
Anorexia	10	35.7	10	31.3	20	33.3	0.787[b]
Nausea, vomiting	12	42.9	11	34.4	23	38.3	0.598[b]
Muscle cramps	25	89.3	27	84.4	52	86.7	0.722[a]
Itching	18	64.3	17	53.1	35	58.3	0.493[b]
Fever	4	14.3	8	25.0	12	20.0	0.349[a]
Dyspnea and tachypnea	17	60.7	14	43.7	31	51.7	0.208[b]
Body weight loss	14	50.0	15	46.9	29	48.3	1.000[b]
Medication type[§]							
Antihypertensive medications	10	35.7	8	25.0	18	30.0	0.366
Oral antidiabetic medications and insulin	13	46.4	10	31.3	23	38.3	0.228
Cardiovascular medications	5	17.9	6	18.8	11	18.3	0.929
Diuretics	16	57.1	22	68.7	38	63.3	0.352
Gastrointestinal medications	13	46.4	13	40.6	26	43.3	0.651
Antiviral medications	–	–	21	65.6	21	35.0	<0.001*
Neurological medications	4	14.3	4	12.5	8	13.3	0.839
Antibacterial medications	–	–	5	15.6	5	8.3	0.029*
Antibiotics	1	3.6	4	12.5	5	8.3	0.212
Other medications (thyroid medications, bone-related medications, iron supplements)	3	10.7	–	–	3	5.0	0.240
CTP class							
A (5-6 points)	11	39.3	14	43.8	25	41.7	
B (7-9 points)	12	42.9	9	28.1	21	35.0	0.433[b]
C (10-15 points)	5	17.9	9	28.1	14	23.3	
CTP Mean±SD	7.3±2.01		7.8±2.38		7.6±2.28		0.594[c]
NRS-2002 Mean±SD	1.68±1.02		1.66±0.94		1.67±0.97		0.979[c]

SD: Standard deviation; NAFLD: Non-alcoholic fatty liver disease; CTP: Child-Turcotte-Pugh; NRS-2002: Nutritional Risk Score-2002; §: More than one option selected; a: Fisher's exact test; b: Pearson Chi-square test; c: Independent samples t test; *: P<0.05.

Table 3. Anthropometric measurements according to gender and etiology

Anthropometric measurements	Women (n=30)		Men (n=30)		pBonf$_1$	pBonf$_2$
	NAFLD (n=17) Mean±SD	Hepatitis B-C (n=13) Mean±SD	NAFLD (n=11) Mean±SD	Hepatitis B-C (n=19) Mean±SD		
Height (cm)	154.8±5.40	158.3±7.50	172.9±6.52	174.1±6.38	0.156^c	0.627^c
Body weight (kg)	76.7±12.07	65.6±15.51	88.8±17.27	78.1±11.09	0.035^c	0.046^c
BMI (kg/m^2)	32.1±5.60	26.0±4.86	29.7±5.51	25.8±3.85	**0.004**^{c*}	0.031^c
MUAC (cm)	31.2±5.17	25.8±7.02	28.4±3.77	27.7±4.41	0.022^c	0.643^c
MAMC (cm)	25.2±4.78	21.1±5.16	23.6±3.24	24.0±4.62	0.036^c	0.026^d
MAMA (cm^2)	44.8±20.90	31.1±17.92	35.1±12.83	37.7±19.60	0.069^c	0.072^d
MAFA (cm^2)	18.2±6.08	12.9±8.01	14.1±5.02	10.8±4.31	0.047^c	0.025^d
TSF (mm)	19.3±5.73	15.0±7.01	15.4±5.17	11.5±5.99	0.073^c	0.085^c
Right handgrip strength (kgf)	13.6±3.81	16.0±4.81	24.5±9.24	31.2±6.00	0.384^c	0.023^c
Left handgrip strength (kgf)	11.8±4.42	15.8±3.98	21.4±7.88	29.4±5.50	0.061^c	0.003^{c*}
Right-left handgrip strength (kgf)	12.7±3.94	15.9±4.23	22.9±8.47	30.3±5.48	0.155^c	0.007^c

NAFLD: Non-alcoholic fatty liver; BMI: Body mass index; MUAC: Middle arm circumference; MAMC: Middle arm muscle circumference; MAMA: Middle arm muscle area; MAFA: Mid-arm fat area; TSF: Triceps skinfold thickness; P values are unadjusted. To account for 11 comparisons, statistical significance was evaluated using a Bonferroni-corrected threshold of p<0.0045 (0.05/11), separately for women and men. p_1: Comparison between NAFLD and hepatitis B/C groups among women; p_2: Comparison between NAFLD and hepatitis B/C groups among men; c: independent-samples t-test; d: Mann–Whitney U test. *p<0.0045.

in cirrhosis patients than in other groups.[22] In the present study, left handgrip strength was significantly higher among men with hepatitis B/C cirrhosis than among men with NAFLD-related cirrhosis after Bonferroni correction. Although handgrip strength is an indirect indicator of muscle function and nutritional status, this finding should be interpreted cautiously given the exploratory design and limited sample size. Decreased muscle mass, which is expected in patients with cirrhosis, may be a valuable predictive factor for malnutrition.[23]

Malnutrition in cirrhosis patients develops with the interaction of many different factors such as metabolic changes in the body, inadequate food intake, hypermetabolism, increased energy requirements as a result of systemic inflammation, nutrient deficiencies, and anorexia. Malnutrition has a significant impact on disease progression and worsens the patient's prognosis.[18] In a study evaluating inadequate protein intake in cirrhotic patients awaiting liver transplantation, the mean protein intake was 1.0±0.36 g/kg/day and only 24% of patients met the recommended protein intake (1.2 g/kg/day protein). Low protein intake (<0.8 g/kg/day) was associated with worse severity of liver disease. Protein intake below 0.8 g/kg/day was found to be an independent predictor of malnutrition and transplant waiting list mortality.[24] In this study, dietary protein intake was below recommended levels in both etiological groups, highlighting the importance of nutritional counseling in all patients with cirrhosis regardless of underlying cause. Nutrition education should emphasize the importance of adequate protein intake and appropriate protein sources. In this study, the lack of significant differences in energy and nutrient intake between groups after multiple comparison correction suggests that some of the observed baseline differences may be statistically coincidental. Uncorrected analyses showed some differences in selected micronutrient intakes; however, these differences did not retain their significance after Bonferroni correction. Nevertheless, the large number of variables involved in nutritional assessments and the limited sample size may have restricted the detection of possible minor differences related to etiology.

NAFLD is a major global health problem linked to several cardiometabolic disorders, including adiposity, insulin resistance, dyslipidemia, metabolic syndrome, and type 2 DM. An inactive lifestyle, diet quality, and obesity are among the factors contributing to the pathophysiology of NAFLD.[25] In a study investigating diet quality, the mean DQI-I score value of participants in the NAFLD group was lower than those in the control group. As a result of the study, it was suggested that greater dietary adherence with a higher DQI-I score may be associated with a lower likelihood of NAFLD.[26] In another study, a 10-unit decrease in DQI-I score was associated with a 24% increase in the probability of having NAFLD (p=0.009). Analyses showed that intake of vegetables and legumes, fruits, and dried fruits as well as Vitamin C was inversely associated with the prevalence of NAFLD (p<0.05).[27] In this study, although the total DQI-I score was lower in the NAFLD group before correction, this difference did not remain statistically significant after Bonferroni adjustment. Furthermore, DQI-I score was not associated with CTP score in the univariate simple linear regression analysis, indicating that diet quality was not an independent determinant of disease severity in this study population.

In this study, higher nutritional risk (NRS-2002) was associated with worse clinical status, whereas overall diet quality assessed by DQI-I was not significantly associated with disease severity in the simple linear regression analysis. Because NRS-2002 incorporates BMI as one of its components, its interpretation in patients with cirrhosis should be made cautiously, particularly in the presence

Table 4. Energy, macronutrient and micronutrient intake mean and standard deviation values according to gender and etiology

	Women (n=30)		Men (n=30)		pBonf$_1$	pBonf$_2$
	NAFLD (n=17) Mean±SD	Hepatitis B-C (n=13) Mean±SD	NAFLD (n=11) Mean±SD	Hepatitis B-C (n=19) Mean±SD		
Energy (kcal/day)	1694.2±349.35	1552.7±368.29	1361.4±375.14	1543.4±265.88	0.292[c]	0.132[c]
Energy (kcal/kg/day)	20.0±6.80	22.1±6.54	18.3±8.06	21.8±3.24	0.234[c]	0.193[c]
Carbohydrate (g)	182.9±44.91	165.2±46.77	140.9±52.33	162.8±42.30	0.302[c]	0.221[c]
Carbohydrates (%)	44.4±6.29	43.5±4.99	41.8±6.06	43.4±7.49	0.684[c]	0.551[c]
Protein (g)	65.6±17.76	54.9±18.53	56.1±16.29	57.8±11.4	0.117[c]	0.740[c]
Protein (g/kg/day)	0.7±0.27	0.7±0.28	0.6±0.26	0.7±0.21	0.971[c]	0.262[c]
Protein (%)	15.5±2.06	14.1±2.30	17.2±2.65	15.4±2.87	0.172[d]	0.101[c]
Vegetable protein (g)	26.1±6.29	23.5±6.30	20.8±6.81	22.5±6.98	0.275[c]	0.514[c]
Animal protein (g)	39.5±12.41	31.3±14.17	35.2±11.88	35.2±9.59	0.103[c]	0.993[c]
Lipid (g)	75.6±18.64	72.8±16.58	61.5±14.88	71.4±18.67	0.665[c]	0.114[c]
Lipid (%)	39.8±6.39	42.3±5.09	41.2±5.68	41.2±6.92	0.246[c]	0.980[c]
SFA (%)	11.9±2.03	13.3±3.09	12.4±2.37	12.9±3.31	0.147[c]	0.672[c]
MUFA (%)	15.2±4.69	15.5±2.83	14.9±3.04	16.1±4.06	0.880[c]	0.402[c]
PUFA (%)	10.3±2.56	10.9±4.50	11.3±3.72	9.6±2.58	0.623[c]	0.139[c]
Omega-3 (%)	1.0±0.04	1.0±0.38	1.0±0.02	1.0±0.03	0.786[d]	0.786[d]
Omega-6 (%)	9.5±2.72	10.1±4.45	10.6±3.59	8.9±2.47	0.917[d]	0.127[c]
Cholesterol (mg)	242.1±113.02	257.3±99.13	206.1±63.24	240.2±66.13	0.703[c]	0.691[d]
Fiber (g)	20.9±6.52	20.5±8.65	19.1±5.64	20.0±6.50	0.882[c]	0.660[d]
Vitamin A (mcg)	1517.0±785.85	898.5±443.70	1618.0±858.14	1253.3±994.91	0.017[c]	0.028[d]
Vitamin E (mg)	19.6±6.98	17.2±6.70	18.4±6.96	16.3±4.42	0.352[c]	0.346[d]
Vitamin K (mcg)	395.3±199.59	279.8±145.12	458.6±180.89	357.0±188.40	0.090[c]	0.160
Vitamin C (mg)	111.9±51.66	111.9±55.81	118.9±59.16	112.6±48.22	0.997[c]	0.753[c]
Thiamine (mg)	0.7±0.24	0.7±0.26	0.6±0.23	0.7±0.18	0.638[c]	0.706[d]
Riboflavin (mg)	1.3±0.50	1.0±0.32	1.2±0.51	1.3±0.39	0.039[c]	0.593[c]
Pantothenic acid (mg)	4.2±1.43	4.1±2.41	3.7±1.31	3.9±0.87	0.426[d]	0.553[c]
Vitamin B6 (mg)	1.2±0.40	1.0±0.37	1.0±0.29	1.0±0.25	0.194[c]	0.901[c]
Folate (mcg)	272.1±79.43	265.0±100.78	236.3±53.77	279.4±77.81	0.831[c]	0.851[d]
Vitamin B12 (mcg)	4.1±1.90	3.4±2.63	3.6±1.15	3.9±3.22	0.180[d]	0.180[d]
Iron (mg)	10.0±3.13	9.0±3.15	9.3±2.33	9.4±2.19	0.415[c]	0.875[c]
Magnesium (mg)	229.3±70.64	206.0±73.55	208.9±54.87	210.5±62.40	0.387[c]	0.945[c]
Zinc (mg)	8.7±2.35	7.4±2.18	7.8±2.14	7.9±1.78	0.157[c]	0.863[c]
Phosphorus (mg)	1104.6±334.89	915.8±283.44	943.1±321.82	996.6±246.90	0.114[c]	0.613[c]
Potassium (mg)	2218.8±737.65	1890.3±695.02	2124.4±661.41	2018.2±504.91	0.226[c]	0.624[c]
Calcium (mg)	809.7±330.82	574.1±215.94	723.8±329.78	732.9±248.02	0.034[c]	0.933[c]

NAFLD: Non-alcoholic fatty liver disease; SFA: Saturated fatty acids; MUFA: Monounsaturated fatty acids; PUFA: Polyunsaturated fatty acids. Bonferroni-adjusted significance level: p<0.0017 (≈ 30 comparisons), p1: Significance test of women according to disease etiology; p2: Significance test of men according to disease etiology; c: Independent samples t test; d: Mann–Whitney U-test.

of ascites and edema, which may influence BMI despite underlying malnutrition. This suggests that disease-specific nutritional assessment tools, such as the Royal Free Hospital–Nutritional Prioritizing Tool or the Global Leadership Initiative on Malnutrition criteria, may provide a more appropriate and sensitive evaluation of nutritional status in this patient population.

Table 5. DQI-I score and DQI-I's categories score mean and standard deviation values according to etiology

	NAFLD (n=28) Mean±SD	Hepatitis B-C (n=32) Mean±SD	pBonf[c]
Variety	9.46±3.33	12.3±4.10	0.100
Overall food group variety	6.82±2.58	9.12±2.99	0.054
Protein-sources variety	2.64±1.33	3.21±1.56	1.000
Adequacy	16.07±7.74	19.21±11.29	1.000
Vegetable group	0.15±0.92	0.78±1.84	0.502
Fruit group	1.78±2.43	2.03±2.49	1.000
Grain group	0.89±1.95	1.87±2.45	1.000
Fibre	2.14±2.51	2.65±0.94	1.000
Protein	4.82±0.94	4.37±1.68	1.000
Iron	2.85±2.51	3.75±2.19	1.000
Calcium	0.17±0.94	0.62±1.68	1.000
Vitamin C	3.21±2.43	3.12±2.45	1.000
Moderation	10.50±4.04	12.00±3.88	1.000
Total fat	0.32±1.70	0.09±0.53	1.000
Saturated fat	0.32±0.94	0.56±1.41	1.000
Cholesterol	4.92±2.19	5.15±1.90	1.000
Sodium	2.03±1.83	2.34±1.97	1.000
Empty calorie foods	3.53±2.16	4.03±2.59	1.000
Overall balance	1.57±1.75	1.75±1.81	1.000
Macronutrient ratio	0.00±0.12	0.00±0.70	1.000
Fatty acid ratio	1.57±1.75	1.62±1.64	1.000
DQI-I (Mean±SD)	36.42±9.01	42.59±15.56	0.426

NAFLD: Non-alcoholic fatty liver disease; DQI-I: Diet quality index–international. pBonf: Bonferroni-adjusted p value; c: independent-samples t-test. Statistical significance was set at pBonf<0.05. *p<0.05.

A positive correlation was observed between CTP and NRS-2002 scores, indicating that nutritional risk increased with disease severity. Consistent with this finding, separate simple linear regression analyses showed that NRS-2002 score was significantly associated with CTP score, whereas DQI-I score was not significantly associated with CTP score. These findings suggest that NRS may better reflect the clinical consequences of cirrhosis than overall diet quality in this study population. Although a significant negative Spearman correlation was observed between DQI-I and CTP score in the overall cohort, DQI-I was not significantly associated with CTP score in the simple linear regression analysis. This discrepancy may reflect differences in the statistical assumptions of correlation and regression analyses; while a monotonic association was observed, DQI-I score did not show a statistically significant linear association with CTP score in the regression model. Therefore, routine nutritional risk assessment using validated screening tools remains an important component of clinical management, although disease-specific instruments may offer additional advantages in patients with cirrhosis.

Table 6. Correlation between CTP, NRS-2002 and DQI-I

	CTP	NRS-2002
CTP		
r	1	
p		
NRS-2002		
r	0.607[e*]	1
p	p<0.001	
DQI-I		
r	-0.328[e]	-0.138[e]
p	0.010*	0.293

CTP: Child-Turcotte-Pugh; NRS-2002: Nutritional risk score-2002; DQI-I: Diet quality index–international; e: Spearman's rho correlation coefficient.

The past decade has seen major changes in the etiology and burden of liver disease. Increased coverage of HBV vaccination and availability of effective antivirals against HBV have contributed to a reduction in global age-standardized mortality rates for HBV-related cirrhosis.[4] In contrast, obesity and diabetes have led to a rapid increase in the prevalence of NAFLD, and global age-standardized mortality rates for NAFLD-related cirrhosis have increased.[28] While the disease burden of HBV-HCV cirrhosis is decreasing, the burden of alcohol-related and

Table 7. Univariate simple linear regression models predicting CTP score from DQI-I and NRS-2002

Group	Predictor	n	B	SE	β	95% CI Lower	95% CI Upper	R^2	F	p
NAFLD	DQI-I	28	0.008	0.044	0.034	-0.083	0.098	0.001	0.029	0.865
NAFLD	NRS-2002	28	0.944	0.338	0.480	0.249	1.639	0.231	7.789	0.010
Hepatitis B-C	DQI-I	32	-0.035	0.029	-0.210	-0.095	0.026	0.044	1.383	0.249
Hepatitis B-C	NRS-2002	32	1.724	0.339	0.680	1.032	2.417	0.463	25.851	<0.001
Total	DQI-I	60	-0.020	0.023	-0.110	-0.066	0.027	0.012	0.711	0.403
Total	NRS-2002	60	1.325	0.243	0.583	0.840	1.811	0.340	29.826	<0.001

CTP: Child-Turcotte-Pugh; DQI-I: Diet quality index-international; NRS-2002: Nutritional risk screening 2002; B: Unstandardized regression coefficient; β: Standardized regression coefficient; SE: Standard error; CI: Confidence interval. Each predictor was entered into a separate simple linear regression model.

NAFLD-related cirrhosis is increasing rapidly. Therefore, the etiology of cirrhosis patients should be analyzed separately and dietary recommendations should be made accordingly; energy and nutrient intake should be carefully monitored in patients with NAFLD-related cirrhosis. This shift highlights the importance of considering etiological background in nutritional assessment; however, causal inferences cannot be drawn from the present study.

This study has some limitations. Due to the relatively small sample size and the exploratory nature of some analyses, multiple comparisons were performed, and the possibility of type I error (false-positive findings) cannot be completely excluded. Appropriate multiple comparison correction was applied where indicated; however, the findings should still be interpreted with caution. Subgroup analyses for hepatitis B and hepatitis C were not performed separately due to the limited sample size, although these two etiologies have distinct natural histories and immunological mechanisms. Therefore, combining these groups may limit the interpretation of etiology-specific findings. In addition, the potential influence of ascites or peripheral edema on body composition measurements represents another limitation of this study. Finally, subgroup analyses, particularly those stratified by sex, were based on relatively small sample sizes and may have been underpowered; thus, these findings require confirmation in larger studies. Since inpatients and outpatients were included in the study, there may be differences in access to food. Handgrip strength measurements may have been affected by missing data on hand dominance; this could lead to variability in grip strength values and should be considered when interpreting subgroup results. In addition, although not statistically significant, the difference in disease duration between groups may still act as a clinically relevant confounder, as prolonged disease course is associated with progressive decline in nutritional status and muscle mass. Since assessment of body fat is important for monitoring body composition, more comprehensive body composition methods should be used in future studies. The multiple anthropometric assessment approach used in this study (TSF, MUAC, MAMC, MAFA, and handgrip strength) offers a robust methodological framework that goes beyond commonly used methods in clinical nutrition research. The use of the internationally validated DQI-I score in assessing diet quality provides a unique contribution in terms of comparing cirrhosis patients according to etiology. On the other hand, the 3-day food intake record method offers a more reliable diet assessment compared to the single-day 24-h recall method. Evaluating cirrhosis according to etiology further enhances the novelty of this study.

Conclusion

This exploratory cross-sectional single-center study compared two different cirrhosis etiologies and identified differences in selected anthropometric measurements, whereas no significant difference in overall diet quality remained after Bonferroni correction. Given the increasing global burden of cirrhosis due to NAFLD, understanding the nutritional requirements of patients with different etiologies is becoming increasingly critical for dietetic management. These findings suggest that dietary assessments and individualized nutritional recommendations provided by dietitians may benefit from consideration of disease etiology. Although studies evaluating the relationship between cirrhosis etiology and diet quality are limited in the literature, the present findings should be interpreted with caution due to the study design and sample size. Further longitudinal, multicenter studies with adequate adjustment for confounders are needed to clarify the relationship between cirrhosis etiology and nutritional status.

Ethics Committee Approval: The study was conducted in accordance with the Declaration of Helsinki and approved by the Baskent University Institutional Review Board and Ethics Committee (Project No: 22/519; Date: January 18, 2023).

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