ORIGINAL RESEARCH ARTICLE

Risk Factors for Malnutrition in Chronic Liver Disease Patients Using RFH-NPT: A Study at Hospital Selayang, Malaysia

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ABSTRACT

Introduction: Malnutrition is highly prevalent among patients with chronic liver disease (CLD), affecting approximately 50-90% of cases. The Royal Free Hospital Nutritional Prioritizing Tool (RFH-NPT) is a validated screening tool for assessing malnutrition risk in CLD patients, yet its use remains limited in clinical and research settings. This study aimed to identify determinants of malnutrition risk in CLD patients at Hospital Selayang.

Methods: A cross-sectional study was conducted among 85 hospitalized CLD patients from March until June 2024. Anthropometric data, including weight, height, BMI, mid-upper arm circumference, and skinfold thicknesses, were collected. Biochemical parameters were retrieved from medical records. Malnutrition risk was assessed using the validated Malay-translated RFH-NPT, while dietary intake and health-related quality of life (HRQoL) were evaluated using 24-hour recall and the SF-36 questionnaire, respectively. Data were analysed using SPSS version 29, employing descriptive statistics, Chi-square/Fisher-Exact tests, and ordinal logistic regression.

Results: Significant associations were found between anthropometric data, HRQoL and malnutrition risk. Low calorie intake (OR = 25.34, p = 0.028), presence of ascites (OR = 0.076, p = 0.004), and emotional role limitation (OR = 0.114, p = 0.004) were independent predictors of malnutrition risk, all of which increased the risk.

Conclusion: These findings support the clinical utility of RFH-NPT in identifying malnutrition risk among CLD patients.

Keywords: Malnutrition, Chronic Liver Disease, RFH-NPT, Nutritional Status, Health-Related Quality of Life

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INTRODUCTION

Chronic liver disease (CLD) is characterized by persistent inflammation, hepatocyte destruction, and tissue repair processes that lead to fibrosis. The causes of CLD are multifactorial and include alcohol abuse, viral hepatitis (B, C, D), autoimmune and metabolic disorders, non-alcoholic fatty liver disease (NAFLD), and long-term use of hepatotoxic medications.[1]

Malnutrition is a frequent complication in CLD, with a reported prevalence of 65% to 100%, regardless of the disease's etiology.[2-4] Moreover, malnutrition rates range from 23 to 60% among liver cirrhosis patients[5,6] and may affect more than half of patients with decompensated cirrhosis, according to current data[7]. The development of malnutrition is attributed to multiple factors including poor dietary intake, anorexia, malabsorption, metabolic alterations, and reduced hepatic storage capacity.[8] Malnourished CLD patients have been shown to experience higher rates of hospitalization, complications, and mortality compared to their well-nourished counterparts.

In addition to nutritional concerns, CLD has a significant impact on health-related quality of life (HRQoL), affecting physical functioning, emotional well-being, and social participation.[9] Patients often report symptoms such as ascites, variceal bleeding, fatigue, pruritus, and psychological distress, all of which reduce their quality of life and daily functioning.[10,11]

Given these challenges, early identification of malnutrition risk and HRQoL impairment is critical. The Royal Free Hospital Nutritional Prioritizing Tool (RFH-NPT) was developed specifically for CLD patients to screen for malnutrition.[12] In addition, compared to other screening tools, it has a high sensitivity and specificity to screen malnutrition in liver cirrhosis. It is also more sensitive than the Nutritional Risk Screening (NRS-2002) for determining patients who are at risk of malnutrition.[13] However, its application in research and clinical practice remains limited, particularly in Malaysia.[14] Although the RFH-NPT is suggested as a screening tool for malnutrition in patients with liver disease, there is little evidence from Asia[12], and its use in Malaysia is also limited. This is due to a lack of widespread validation in Asian populations, particularly in Malaysia, with only preliminary results from single-center studies indicating that RFH-NPT has a sensitivity of 97%, specificity of 74%, and higher detection rates among Child-Pugh C patients.[14] As a result, more research towards using RFH-NPT to determine malnutrition risk in CLD patients is needed to justify its widespread use.

Therefore, this study aims to evaluate the determinants of malnutrition among CLD patients using the RFH-NPT tool at Hospital Selayang, Selangor. The findings are expected to support improved screening and early intervention strategies tailored to the Malaysian clinical context.

METHODOLOGY

Participants: A cross-sectional study was conducted among 85 patients diagnosed with chronic liver disease (CLD), aged between 18 and 85 years, who were admitted to Hospital Selayang between March and June 2024. A cross-sectional design was chosen as it allows data on exposures and outcomes to be collected simultaneously within a defined period. This approach was particularly suitable given the study's time constraints, as it is more efficient and less resource-intensive compared to longitudinal designs. The study was carried out at the Department of Hepatology, Hospital Selayang, Malaysia's national tertiary referral center for liver disease. Eligible participants were adults (18-85 years) with a confirmed diagnosis of CLD who were able to communicate, literate, and provided informed consent. Exclusion criteria included individuals below 18 years of age, those receiving enteral nutrition via tube feeding on ventilator support, with neurological impairments, illiterate, or unwilling to participate. The sample size was determined by the number of eligible patients admitted during the study period, taking into account the study's limited timeframe and available resources. As the Department of Hepatology at Hospital Selayang is Malaysia's national tertiary referral centre for liver disease, this setting ensured a representative mix of CLD patients across various stages and backgrounds. Sampling was purposive, as participants were selected based on predefined inclusion and exclusion criteria (age, diagnosis, ability to communicate, and consent). This approach ensured that only patients relevant to the research objectives were included, thereby enhancing the study's focus and validity.

Study instrument: Data were collected through structured interviews and review of medical records. A specifically designed questionnaire was used to obtain participants' socio-demographic data, including age, gender, ethnicity, education level, and employment status. Anthropometric measurements were conducted by trained personnel using standardized protocols, biochemical parameters relevant to liver function were extracted from the patients' medical records and dietary records were also obtained.

Anthropometric measurements: The anthropometric measurements were conducted to obtain weight, height, BMI, mid-upper arm circumference (MUAC), and skinfold thicknesses [tricep skinfold thickness (TSF), chest skinfold thickness (CST), and subscapular skinfold thickness (SST)]. Patients who were capable of standing erect were using a stadiometer and a weighing scale to obtain their weight and height. However, patients who could not stand on a weighing scale required an additional knee height (KH) measurement besides mid-upper arm circumference (MUAC). The MUAC and KH were measured using a measuring tape and located carefully to avoid inaccuracies. For patients who were unable to stand on a weighing scale, their weights

were estimated using knee height (KH) and mid-upper arm circumference (MUAC) with the formula of (i) men: weight = (1.10 x KH) + (3.07 x MUAC) - 75.81 or (ii) women: weight = (1.01 x KH) + (2.81 x MUAC) - 66.04].[15] On the other hand, for patients who were unable to stand on a stadiometer, their heights were estimated using knee height (KH) with the formula of (i) men: height = 69.38 + (1.924 x KH) or (ii) women: height = 50.25 + (2.225 x KH)].[16] Aside from estimating the weight of the patients, MUAC can also determine the muscle mass of CLD patients. According to Hu et al.[17] (2021), the optimal cut-off values for predicting low muscle mass were ≤28.6 cm for males, and ≤27.5 cm for women. To reduce inter-observer variability, all anthropometric measurements were taken by one trained researcher. Thus, inter-rater reliability was not evaluated.

The body mass index (BMI) was determined from the weight or estimated weight and height or estimated height data that were collected from the patients [BMI = weight/height^2 (kg/m^2)]. The patients were categorized according to their calculated BMI as underweight (<18.5 kg/m^2), normal (18.5 - 24.9 kg/m^2), overweight (25.0 - 29.9 kg/m^2), and obese ≥30.0 kg/m^2. However, different BMI classifications will be used for elderly participants aged ≥65 years old. They will be categorized according to underweight (<23 kg/m^2), normal (24 - 30 kg/m^2), and overweight (>30 kg/m^2).[18] A different BMI is applied for those aged ≥65 years old because weight change, changes in body composition, height loss, or a combination of these factors can all alter BMI results and lead to BMI-based implications in older persons. The use of standard BMI categories throughout life does not represent our current understanding of adiposity changes caused by age or sex differences in adiposity.[19] The skinfold thicknesses were measured using a skinfold calliper. Body density was calculated before the body fat percentage, with the formula of

(i) men: body density = 1.1125025 - 0.0013125(X3) + 0.0000055(X3)^2 - 0.0002440(X2), and
(ii) women: body density = 1.089733 - 0.0009245(X4) + 0.0000025(X3)^2 - 0.0000979(X2).

[X2 = age in years; X3 = the sum of the tricep, chest, and subscapular measurements in millimetres). Then, the body fat percentage was calculated with the formula [body fat percentage = (4.95/body density - 4.5) x 100]. Body fat percentages were classified into low (<10%), normal (10-20%), and high (>20%).[20]

Biochemical data: The biochemical data on albumin, total bilirubin, alanine aminotransferase (ALT), aspartate aminotransferase (AST), and alkaline phosphatase (ALP) were obtained from patients' latest blood and liver tests in medical records. The normal albumin and total bilirubin values were 3.5 - 5 g/dL and 5 - 21 mmol/L, respectively. Meanwhile, the range of normal values for alanine aminotransferase (ALT), alkaline phosphatase (ALP), and aspartate aminotransferase (AST) were 0 - 50 U/L, 43 - 115 U/L, and 0 - 50 U/L, respectively.

Food/Nutrition-Related History: Patients' dietary intake, mainly energy and protein, was assessed by conducting a multiple-pass 24-hour diet recall. This method consists of three stages to gather information on patients' food intake over the previous 24 hours. The first stage is the quick list or open call; patients were asked to recollect what they had eaten the day before without interruption. The second stage is the detailed description, patients were probed for more information on the exact time, type, and quantity of food or drink consumed. The last stage is a review. This is when the list of meals described will be gone through, and additional eating time will be inquired. This method was said to maximize recall accuracy for quantitation.

Royal Free Hospital Nutritional Prioritizing Tool (RFH-NPT): A validated Malay-translated Royal Free Hospital Nutritional Prioritizing Tool (RFH-NPT) was used as a nutritional screening tool to detect malnutrition among CLD patients.[14] This tool was also used to determine the presence of ascites among the patients. The RFH-NPT scores of the patients were calculated. RFH-NPT will classify the patients according to their score: 0 points = low risk, 1 point = moderate risk, and 2-7 points = high risk. There were three steps to perform the RFH-NPT. Firstly, the patients with alcoholic hepatitis or who were receiving tube feeding were directly categorized in the high-risk group and did not proceed to the next stage. Secondly, patients with ascites or edema were differentiated from patients without them. Lastly, patients without ascites or edema were evaluated for nutritional status, including daily dietary intake, unplanned weight loss, and BMI. Then, they will be categorized according to the scores. However, the moderate and high-risk groups were grouped together to form a single 'moderate-to-high risk' group for analysis to guarantee clinical relevance and statistical reliability. Clinically, both moderate and high-risk groups require nutritional intervention by dietitians and have similar negative results, including decreased mortality and disease progression, when compared to the low-risk group.[18,21] From a statistical standpoint, combining these groups improved the statistical significance of our comparisons and enabled greater survival models between individuals with 'low' and 'moderate-to-high' risks.

Health-Related Quality of Life: The Short Form 36 (SF-36) was utilized to analyse CLD patients' health-related quality of life (HRQoL). SF-36 is a scoring system, made up of 36 questions that were divided into eight (8) components. There was physical functioning, role restrictions due to physical health, emotional well-being, role restrictions due to emotional problems, vitality (energy and fatigue), general mental health, bodily pain, and overall health perceptions. The scores for the various components were converted and collected using the RAND scoring table to get an overall score representing a range of

low to high quality of life (QoL). This study utilized both the approved Malay and English versions of the SF-36.[22] SF-36 score ≥60 cut-off point was established for excellent physical function.[23]

Ethical and Data Collection Procedure: The data collection was conducted at the Department of Hepatology, Hospital Selayang, from March to June 2024. Ethical approval for this study was obtained from the Malaysian Medical Research and Ethics Committee (MREC) (Reference number: NMRR-24-00053-T4H) dated 21st February, 2024. authorizing all procedures outlined in the study protocol. Prior to data collection, the study objectives and procedures were clearly explained to each eligible participant. Informed consent was obtained in accordance with the principles of the Declaration of Helsinki. All patient information was kept strictly confidential, and data were anonymized prior to analysis. Electronic data were stored securely with password protection, accessible only to the research team.

Eligible chronic liver disease (CLD) patients were approached in person during their hospital stay. Those who met the inclusion criteria and agreed to participate were enrolled in the study. Data collection included face-to-face interviews using structured questionnaires to obtain socio-demographic information and dietary intake history. Anthropometric measurements, including weight, height, BMI, mid-upper arm circumference (MUAC), and skinfold thicknesses were taken using standardized techniques. Biochemical data such as serum albumin, total bilirubin, ALT, AST, and ALP were obtained from patients' medical records.

The Royal Free Hospital Nutritional Prioritizing Tool (RFH-NPT), translated and validated in Malay, was used to assess malnutrition risk. In addition, the Short Form 36 (SF-36) questionnaire was administered to evaluate health-related quality of life (HRQoL). Each session lasted approximately 20 to 30 minutes, providing sufficient time for open communication and accurate responses in a comfortable and confidential environment.

Data Analysis: All data collected were analysed using the Statistical Package for Social Science (SPSS) 29.0 version. Besides, the Nutritionist Pro software was used to analyse the patients' dietary intake. The nutritional status and the quality of life of CLD patients, including any baseline parameters, were described in detail by descriptive statistics. In this study, the numerical data were stated as mean and standard deviation (SD). On the other hand, the categorical data were shown as frequency and percentages (%). Moreover, a Chi-square or Fisher-Freeman-Halton Exact test was used to analyse the association between variables of RFH-NPT malnutrition risk with socio-demographic data, nutritional status, and health-related quality of life. An ordinal logistic regression was used to investigate the determinants of malnutrition and to observe any relevant independent variables. Prior to conducting the ordinal logistic regression, assumptions were tested. The proportional odds assumption was assessed using the Test of Parallel Lines, if the result was non-significant ($p > 0.05$), it indicates that the assumption was met. The variance inflation factor (VIF) was used to assess multicollinearity among independent variables. All values <10 and tolerance values >0.1 were determined to be acceptable. There were no missing data for the variables examined in this study. However, any missing data were eliminated from the final analysis.

RESULTS

The characteristics of CLD patients according to socio-demographic, anthropometric, and biochemical data, as well as food/nutrition-related history, are shown in Table 1. The patients' mean age was 55, with a standard deviation of 14.66. Among the patients, 55 (64.7%) patients were ≥51 years old, while the remaining 30 (35.3%) patients were ≤50 years old. Regarding gender, 43 (50.6%) patients were male, while the other 42 (49.4%) were female. This study also included a diverse group of individuals, with 42 (49.4%) being Malay, 29 (34.1%) being Chinese, and 14 (16.5%) being Indian. Patients who were present with ascites were only 19 (22.4%), while the rest of 66 (77.6%), did not. Non-alcoholic fatty liver disease (NAFLD) and hepatitis B or C were the main causes of liver disease among the patients, contributing to 28.2% and 27.1%, respectively. The anthropometric data shows that the mean BMI of the patients was 24.83 ± 5.24 kg/m^2. Following WHO and Queensland guidelines on BMI for adults and the elderly, the BMI was divided into four categories. Among the patients, 19 (22.4%) were underweight, 34 (40%) were normal, 28 (32.9%) were overweight, and 4 (4.7%) were obese. The mean of mid-upper arm circumference (MUAC), triceps skinfold thickness (TSF), and body fat percentages were 26.30 ± 5.15 cm, 12.76 ± 5.77 mm, and 18.09 ± 5.63 respectively. Each MUAC and TSF were categorized into low and normal categories. The majority of the patients had normal MUAC and TSF (46, 54.1%) compared to low MUAC and TSF (39, 45.9%). Besides, body fat percentages were categorized into low, normal, and high. The majority of the patients had normal body fat percentages (59, 69.4%), compared to low (17, 20%) and high (9, 10.6%).

The mean of albumin was 30.61 ± 7.56 g/L, which is below the normal range, while the mean of total bilirubin was 134.60 ± 155.62 μmol/L, which is above the normal range. The majority of patients had low albumin levels (67.1%) and high total bilirubin levels (76.5%) in contrast to those with normal values for albumin and total bilirubin, which were 32.9% and 23.5%, respectively. The mean of alanine aminotransferase (ALT), alkaline phosphatase (ALP), and aspartate aminotransferase (AST) of the patients were 67.66 ± 65.58 U/L, 195.38 ± 121.61 U/L, and 94.39 ± 83.58 U/L, respectively.

Table 1: Characteristics of Chronic Liver Disease Patients in Hospital Selayang (N=85)

Variable	Patients (%)
Socio-demographic data	
Age, Mean ± SD, years	55.58 ± 14.66
≤50 years	30 (35.3)
≥51 years	55 (64.7)
Gender, n (%)	
Male	43 (50.6)
Female	42 (49.4)
Race, n (%)	
Malay	42 (49.4)
Chinese	29 (34.1)
Indian	14 (16.5)
Ascites, n (%)	
Yes	19 (22.4)
No	66 (77.6)
Causes of liver disease, n (%)	
NAFLD	24 (28.2)
Alcohol	16 (18.8)
Autoimmune	5 (5.9)
Hepatitis B/C	23 (27.1)
Other	17 (20.0)
Anthropometric data	
BMI (kg/m²)	24.83 ± 5.24
Underweight	19 (22.4)
Normal	34 (40.0)
Overweight	28 (32.9)
Obese	4 (4.7)
MUAC (cm)	26.30 ± 5.15
Low	39 (45.9)
Normal	46 (54.1)
TSF (mm)	12.76 ± 5.77
Low	39 (45.9)
Normal	46 (54.1)
Body fat percentage (%)	18.09 ± 5.63
Low	17 (20.0)
Normal	59 (69.4)
High	9 (10.6)
Biochemical data	
Albumin (g/L)	30.61 ± 7.56
Low	57 (67.1)
Normal	28 (32.9)
Total bilirubin (μmol/L)	134.60 ± 155.62
Normal	20 (23.5)
High	65 (76.5)
Alanine aminotransferase (U/L)	67.66 ± 65.58
Normal	42 (49.4)
High	43 (50.6)
Alkaline phosphatase (U/L)	195.38 ± 121.61
Normal	27 (31.8)
High	58 (68.2)
Aspartate aminotransferase (U/L)	94.39 ± 83.58
Normal	29 (34.1)
High	56 (65.9)
Food/nutrition-related history	
Calorie intake (kcal/kg/day)	15.26 ± 5.71
Protein intake (kcal/kg/day)	0.64 ± 0.29

Note: Descriptive test used. Values are presented as the mean ± standard deviation or the number of participants (%). BMI=body mass index; MUAC=mid-upper arm circumference; TSF=tricep skinfold thickness.

The majority of patients have mean ALT, ALP, and AST values that are above the normal range (50.6%, 68.2%, and 65.9%, respectively). The patients' mean calorie and protein intakes were 15.26 ± 5.71 kcal/kg/day and 0.64 ± 0.29 g/kg/day, respectively.

Table 2: Descriptive Statistics of Health-Related Quality of Life (HRQoL) of Chronic Liver Disease Patients in Hospital Selayang (N=85)

Domains of HRQoL	Score (Mean±SD)
Physical functioning	50.29±22.98
Role limitations due to physical health	41.47±38.68
Role limitations due to emotional problems	67.45±35.63
Energy/fatigue	58.12±18.64
Emotional well-being	63.86±12.66
Social functioning	85.44±14.67
Bodily pain	73.59±18.61
General health perceptions	54.47±16.22

Note: Descriptive test used. Values are presented as the mean ± standard deviation.

Table 3: The Level of Health-Related Quality of Life of Chronic Liver Disease Patients in Hospital Selayang (N=85)

Variable	HRQoL	
	Poor (%)	Good (%)
Physical functioning	45 (52.9)	40 (47.1)
Role limitations due to physical Health	57 (67.1)	28 (32.9)
Role limitations due to emotional problems	25 (29.4)	60 (70.6)
Energy/fatigue	42 (49.4)	43 (50.6)
Emotional well-being	32 (37.6)	53 (62.4)
Social functioning	14 (16.5)	71 (83.5)
Bodily pain	16 (18.8)	69 (81.2)
General health perceptions	49 (57.6)	36 (42.4)

Note: Descriptive test used. Values are presented as the number of participants (%).

Both intakes were lower than the recommended intakes. American Society of Parenteral and Enteral Nutrition (ASPEN) recommends that the energy intake of CLD patients without encephalopathy be 25 - 35 kcal/kg/day. Meanwhile, the European Society for Clinical Nutrition and Metabolism (ESPEN) recommended that protein intake for CLD participants is 1.2 - 1.5 g/kg/day (Table 1).

All eight domains of the SF-36 questionnaire for assessing patients' health-related quality of life are shown in Table 2. The mean physical functioning was 50.29 ± 22.98. This indicates that patients lost about 50% of their physical functioning. Besides, patients experienced role limitations due to physical health, with mean scores of 41.47 ± 38.68. Most patients have slight role limitations due to emotional problems, with mean scores of 67.45 ± 35.63. The participants have lost about 42% of their energy due to their conditions, with a mean score of 58.12 ± 18.64. The overall patients' emotional well-being was slightly good, with a mean of 63.86 ± 12.66. Moreover, the patients' social functioning also seems to be good and not to have been affected by their conditions, with a mean of 85.44 ± 14.67. In addition, the patients have not been badly affected by bodily pain, as the mean score was 73.59 ± 18.61. Overall, the general health perceptions of the participants were slightly low, with a mean of 54.47 ± 16.22.

Table 4: The Association Between Socio-Demographic, Anthropometric, and Biochemical Data, Food/Nutrition-Related History, and Health-Related Quality of Life with RFH-NPT Malnutrition Risk Classification (N=85)

Variables	RFH-NPT Risk Classification		P-value
	Low (*n*=43) (%)	Moderate – High (*n*=42) (%)	
Socio-demographic data			
Age			
≤50 years	15 (34.9)	15 (35.7)	0.936
≥51 years	28 (65.1)	27 (64.3)	
Gender			
Male	19 (44.2)	24 (57.1)	0.232
Female	24 (55.8)	18 (42.9)	
No Ascites	39 (90.7)	27 (64.3)	0.003*
Anthropometric data			
Extreme BMI (kg/m²)	29 (67.4)	22 (52.4)	0.156
Low MUAC (cm)	27 (62.8)	32 (76.2)	0.18
Low TSF (mm)	15 (34.9)	24 (57.1)	0.039*
Body fat percentage (%)			
Low	6 (14.0)	11 (26.2)	0.119
Normal	30 (69.8)	29 (69.0)	
High	7 (16.3)	2 (4.8)	
Biochemical data			
Low Albumin (g/L)	25 (58.1)	32 (76.2)	0.077
High Total bilirubin (μmol/L)	34 (79.1)	31 (73.8)	0.568
High Alanine aminotransferase (U/L)	21 (48.8)	22 (52.4)	0.744
High Alkaline phosphatase (U/L)	26 (60.5)	32 (76.2)	0.119
High Aspartate aminotransferase (U/L)	26 (60.5)	30 (71.4)	0.286
Food/nutrition-related history			
Low Calorie intake (<25 kcal/kg/day)	36 (83.7)	40 (95.2)	0.084[a]
Low Protein intake(<1.2 g/kg/day)	38 (88.4)	42 (100.0)	0.055[a]
HRQoL			
Good Physical functioning	18 (41.9)	27 (64.3)	0.038*
Good Role limitations due to physical health	20 (46.5)	8 (19.0)	0.007*
Good Role limitations due to emotional problems	38 (88.4)	22 (52.4)	<0.001*
Good Energy/fatigue	24 (55.8)	19 (45.2)	0.33
Poor Emotional well-being	10 (23.3)	22 (52.4)	0.006*
Good Social functioning	38 (88.4)	33 (78.6)	0.223
Good Bodily pain	36 (83.7)	33 (78.6)	0.544
Good General health perceptions	22 (51.2)	14 (33.3)	0.096

Values are presented as the mean ± standard deviation or the number of participants *(%)*. BMI=body mass index; MUAC=mid-upper arm circumference; TSF=tricep skinfold thickness; HRQoL=health-related quality of life. *Chi-square test* was used unless otherwise stated. [a]*Fisher-Freeman-Halton Exact test*. *Significant association at p-value <0.05. For analysis, the moderate and high-risk groups were combined to form a single "moderate-to-high risk" category.

Table 5: Determinants of Malnutrition among Chronic Liver Disease Patients in Hospital Selayang (N=85)

Variable	Univariate analysis			Multivariate analysis		
	cOR	95% CI	P value	aOR	95% CI	P value
Socio-demographic data						
Age ≤50 years (vs ≥51 years)	1.037	0.426, 2.525	0.936	1.657	0.413, 6.655	0.476
Female Gender (vs Male)	0.594	0.252, 1.400	0.234	1.003	0.255, 3.939	0.997
No Ascites (vs Yes)	0.185	0.055, 0.617	0.006*	0.076	0.013, 0.440	0.004*
Anthropometric data						
Extreme BMI (kg/m²) (vs Normal)	0.531	0.220, 1.280	0.158	0.928	0.236, 3.652	0.915
Low MUAC (cm) (vs Normal)	2.489	1.037, 5.974	0.041*	3.654	0.841, 15.873	0.084
Low TSF (mm) (vs Normal)	2.489	1.037, 5.974	0.041*	2.799	0.661, 11.852	0.162
Food/nutrition-related history						
Low Calorie intake (vs Normal)	3.889	0.758, 19.942	0.103	25.336	1.426, 450.281	0.028*
HRQoL						
Good Physical functioning (vs Poor)	0.4	0.167, 0.959	0.040*	1.794	0.288, 11.179	0.531
Good Role limitations due to physical health (vs Poor)	0.271	0.102, 0.718	0.009*	0.385	0.099, 1.495	0.168
Good Role limitations due to emotional problems (vs Poor)	0.145	0.048, 0.440	0.001*	0.114	0.025, 0.509	0.004*
Poor Emotional well-being (vs Good)	3.63	1.430, 9.212	0.007*	5.098	0.690, 37.641	0.11

BMI=body mass index; MUAC=mid-upper arm circumference; TSF=tricep skinfold thickness; HRQoL=health-related quality of life. cOR – Crude/unadjusted Odds Ratio; aOR – Adjusted OR. *Significant association at p-value <0.05.

Each domain has been categorized as poor and good, with a total score of <60, and ≥60, respectively. 45 (52.9%) of patients have poor physical functioning, while 40 (47.1%) of patients have good physical functioning. More CLD patients had poor role limitations due to physical health (57, 67.1%) compared to good (28, 32.9%). In contrast, more patients have better role limitations due to emotional problems (60, 70.6%) than poor scores (25, 29.4%). There was just one point difference between people with greater energy levels and those with lower energy, with 43 (50.6%) compared to 42 (49.4%), respectively. Besides, majority of the patients had good emotional well-being, social functioning, and bodily pain, with a total of 53 (52.4%), 71 (83.5%), and 69 (81.2%), respectively, as opposed to low with a total of 32 (37.6%), 14 (16.5%), and 16 (18.8%). Overall, more participants had poor health perceptions (49, 57.6%) than good health perceptions (36, 42.4%) (Table 3).

The association between socio-demographic, anthropometric, and biochemical data, food/nutrition-related history, and health-related quality of life with RFH-NPT malnutrition risk are shown in Table 4. Overall, 43 (50.59%) of CLD patients were classified as low risk (0 point) for malnutrition using RFH-NPT, while 42 (49.41%) were classified as moderate-high (0 to 1 point) risk for malnutrition with 11 (12.94%) were in the moderate group and 31 (36.47%) were in the high risk (2 to 7 points) group. There was a significant association between ascites and malnutrition risk ($p<0.05$). However, BMI, MUAC, and body fat percentage were not significantly associated with the risk of malnutrition among CLD patients ($p>0.05$). Tricep skinfold thickness (TSF) was significantly associated with the malnutrition risk ($p<0.05$). All the biochemical data obtained from the patients were not significantly associated with the malnutrition risk as $p>0.05$. The calorie and protein intake were analyzed using the Fisher-Freeman-Halton Exact test. This test showed that calorie and protein intakes were not significantly associated with malnutrition risk among CLD patients ($p>0.05$). Even so, low calorie and protein intakes were common among CLD patients, especially among moderate-high-risk patients. Besides, the domains of the HRQoL questionnaire (SF-36), such as physical functioning, role limitations due to physical health, role limitations due to emotional problems, and emotional well-being, were significantly associated with the malnutrition risk ($p<0.05$). Nevertheless, the remaining domains were not statistically significant, as $p>0.05$.

Table 5 shows the determinants of malnutrition in chronic liver disease patients in Hospital Selayang, where the univariate and multivariate analyses of the malnutrition risk are stated. Both analyses determined which variables are more likely to be associated with the dependent variable. The univariate analysis found that ascites ($p = 0.006$), MUAC ($p = 0.041$), TSF ($p = 0.041$), physical functioning ($p = 0.040$), role limitations due to physical health ($p = 0.009$), role limitations due to emotional problems ($p = 0.001$), and emotional well-being ($p = 0.007$) were all significantly associated with a risk of malnutrition. Meanwhile, the multivariate analysis discovered the presence of ascites (OR = 0.076, 95% CI: 0.013, 0.440, $p = 0.004$), low calorie intake (OR = 25.336, 95% CI: 1.426, 450.281, $p = 0.028$), and good role limitations due to emotional problems (OR = 0.114, 95% CI: 0.025, 0.509, $p = 0.004$) were the independent risk factors of malnutrition risk determined by RFH-NPT among CLD patients in Hospital Selayang. In contrast, age (OR = 1.657, 95% CI: 0.413, 6.655, $p = 0.476$), gender (OR = 1.003, 95% CI: 0.255, 3.939, $p = 0.997$), BMI (OR = 0.928, 95% CI: 0.236, 3.652, $p = 0.915$), MUAC (OR = 3.654, 95% CI: 0.841, 15.873, $p = 0.084$), TSF (OR = 2.799, 95% CI: 0.661, 11.852, $p = 0.162$), physical functioning (OR = 1.794, 95% CI: 0.288, 11.179, $p = 0.531$), role limitations due to physical health (OR = 0.385, 95% CI: 0.099, 1.495, $p = 0.168$), and emotional well-being (OR = 5.098, 95% CI: 0.690, 37.641, $p = 0.110$) were not significantly associated with malnutrition risk.

Discussion

This study assessed CLD patients' nutritional status by anthropometric, biochemical data, and food/nutrition-related history. In this study, most CLD patients had extreme BMI (51, 60%), while others had a normal BMI (34, 40%). Extreme BMI typically refers to BMI values at the upper and lower ends of the BMI scale, indicating underweight (adult: <18.5 kg/m^2; elderly: <23 kg/m^2), overweight (adult: 25.0-29.9 kg/m^2; elderly: >30 kg/m^2), or obesity (≥30 kg/m^2). A previous study found that patients with a BMI <18.5 kg/m^2 and/or Child-Pugh class C or decompensated cirrhosis are more likely to experience malnutrition.[24] BMI evaluation is important since it has been associated with mortality in patients with CLD. This study also found that CLD patients have lower mean TSF and MUAC scores than the references. According to Ndraha S & Simadibrata M[25] (2009), CLD patients were classified as malnourished if their TSF and/or MUAC fell below the 5th percentile for their age and gender, according to standard Swedish population tables.

Patients' serum albumin decreased below the reference range, while patients' total bilirubin was elevated above the reference range, consistent with the previous study. Oettl K et al.[26] (2013) found in both cirrhotic and septic patients among their studied population, total bilirubin and CRP levels increased while albumin levels decreased compared to controls. Decreased albumin levels are associated with advanced liver disease that impairs albumin structure and function through various processes, including decreasing plasma levels due to diminished production, oxidative modification, and bilirubin-occupied binding sites.[27] Besides, low albumin levels also indicate impaired liver function and a poor prognosis for people with liver cirrhosis while total bilirubin is a key indicator for liver function.[28] CLD

patients have an insufficient energy intake. This may have occurred as CLD patients are associated with early satiety, nausea, vomiting, and food absorption problems, affecting their normal dietary intake.[29] Protein intake was also decreased among CLD patients. This might be due to altered macronutrient metabolism, such as hypermetabolism, which often occurs among CLD patients, causing an increase in their protein requirements.[30] However, consistent insufficient protein intake will increase the risk for malnutrition, as well as lead to poor clinical outcomes among CLD patients. Low protein intake especially among liver cirrhosis patients will increase protein catabolism and aggravate hepatic encephalopathy.[31] Moreover, cirrhotic patients also require more protein than healthy people due to PEM, muscle breakdown, and protein-losing enteropathy induced by portal hypertension, which can lead to increased intestinal protein losses.[31]

Generally, CLD patients may experience a decline in HRQoL due to hepatic events, the severity of liver fibrosis, and advancing age.[32] Two studies found that CLD patients had significantly lower mean scores across all HRQoL domains.[33,34] However, from this study, the participants' mean of HRQoL was significantly poor for physical functioning, role limitations due to physical health, energy or fatigue, and general health perceptions. Meanwhile, the mean of HRQoL for role limitations due to emotional problems, emotional well-being, social functioning, and bodily pain was significantly good among CLD patients. Compared to Abdul Hamid & Roslan[35] (2020), our study found similar findings on all of the HRQoL domains, except for role limitations due to emotional problems, in which our study had better outcomes, possibly due to social factors (e.g., strong social and family support). The quality of life reflects how various conditions impact their life. Patients with CLD experience a wide range of symptoms that have a significant negative impact on their health-related quality of life.

The current study found no significant association between all socio-demographic data and the malnutrition risk among the patients. The current study also found that ascites was significantly associated with the malnutrition risk, similar to previous studies. It was reported that patients with liver cirrhosis and ascites have an increased risk of malnutrition when screening with the RFH-NPT.[36,37] According to Wu Y et al.[12] (2020), the RFH-NPT is more efficient to identify the risk of malnutrition in CLD patients than the NRS-2002 as it incorporates the disease-specific parameters. Hence, it is more sensitive to determine the nutritional problems among CLD patients. Moreover, the current study also found that BMI was not significantly associated with the malnutrition risk. BMI may not be an appropriate measure for measuring the nutritional status of individuals with advanced liver disease since it does not take into consideration body composition, including edema and ascites. However, fluid retention impacts the BMI, hence malnourished people will be classified as overweight.[38] While TSF was significantly associated with malnutrition risk, a study also discovered that malnourished CLD patients had a lower distribution in the upper percentiles for TSF, MAC, and MAMC, indicating a depletion of fat and muscle stores among the patients.[39] Moreover, the MAC and TSF show inconsistent results and have not been found to be strong indicators of malnutrition.[12] This study could not find a significant association between MUAC, calorie and protein intakes, and biochemical data, especially albumin with the malnutrition risk. In fact, albumin is a standard measure, considered to represent liver synthetic function rather than nutritional status.[12] Nevertheless, previous studies have found a significant association between MUAC, calorie, and protein intakes, and albumin with malnutrition risk[40] as cited in Georgiou A et al.[41], 2021 and Yao J et al.[42], 2019. The lack of association between certain parameters such as BMI, biochemical data, and MUAC with malnutrition risk in this study could be due to the specific focus of the RFH-NPT. Rather than focusing solely on weight or BMI, RFH-NPT focuses more on fluid overload, unintentional weight loss, and reduced oral intake which are highly relevant in cirrhosis. Hence, this explains why RFH-NPT is generally more sensitive than generic techniques in cirrhosis cohorts.[12] Regarding HRQoL, some components were significantly associated with the risk of malnutrition. Physical functioning, role limitations due to physical health, role limitations due to emotional problems, and emotional well-being were statistically significant with malnutrition risk among the patients. This was consistent with the previous study, in which they reported malnutrition was linked to worse HRQoL subscales, including physical functioning, role-physical, general health, vitality, social functioning, and role-emotional.[43]

Several factors have initially been determined as potential determinants of malnutrition among CLD. However, ordinal logistic regression analysis identified calorie intake, ascites, and role limitations due to emotional problems as the primary factors influencing malnutrition among CLD. This study found that the absence of ascites was associated with lower odds of being at a higher risk of malnutrition. According to a study, ascites can interfere with stomach accommodation, which may cause pain after meals and add striking early satiety.[44] Bischoff SC et al.[45] (2020) also found that malnutrition was associated with a higher prevalence of ascites among cirrhotic patients. This study also found that low calories were associated with higher odds of being at a higher risk of malnutrition. Cirrhotic patients tended to reduce their dietary intake as the disease progressed.[45] Elsebaie EM et al.[44] (2023) found multiple studies that had previously reported a decrease in daily calorie intake was related to increased mortality among CLD patients. Although significant, the wide confidence interval shows possible inaccuracies in the effect estimate, most likely due to small sample size and variability in dietary assessment. Hence, the

strength of the association should be regarded with caution, even if statistically significant. Besides, good role limitations due to emotional problems were associated with lower odds of being at a higher malnutrition risk and the other way around. This was consistent with the previous study by Chiu E et al.[43] (2020), in which they found that malnutrition was linked to decreased role-emotional, as well as the other HRQoL domains, such as physical functioning, role-physical, overall health, vitality, and social functioning. It was discovered that malnutrition can lead to lower role-emotional scores, similar to those with chronic obstructive pulmonary disease.[43]

Strengths

This study offers valuable insights into the nutritional status and quality of life of chronic liver disease (CLD) patients using a comprehensive and disease-specific assessment approach. One of its key strengths is the use of the Royal Free Hospital Nutritional Prioritizing Tool (RFH-NPT), a validated screening tool specifically designed for CLD patients, which enhances the accuracy of malnutrition risk detection. The study also applied standardized anthropometric and biochemical measurements, and included both objective data (e.g., albumin, MUAC, TSF) and subjective data (e.g., dietary recall and HRQoL using SF-36), allowing for a multidimensional understanding of patients' nutritional and functional status. The study setting, Hospital Selayang, a national hepatology referral center, adds to the clinical relevance and applicability of the findings in tertiary care.

Limitations

Despite its strengths, the study has several limitations. The cross-sectional design limits the ability to establish causality between identified factors and malnutrition risk. The sample size (n=85), though adequate for exploratory analysis, may limit the generalizability of findings to broader populations. Additionally, weight and height estimation using knee height and MUAC in non-ambulatory patients may introduce measurement variability. The use of 24-hour dietary recall, while practical, may be subject to recall bias and under-reporting. Lastly, some parameters such as biochemical markers and BMI may be affected by fluid retention (e.g., ascites), potentially reducing their reliability in this patient group.

Conclusion

This study explored the nutritional status and determinants of malnutrition among chronic liver disease (CLD) patients using the Royal Free Hospital Nutritional Prioritizing Tool (RFH-NPT). The results revealed that traditional markers such as BMI, MUAC, and biochemical values were not significantly associated with malnutrition risk, likely due to complications like ascites that affect body composition assessments. However, ascites, low calorie intake, and role limitations due to emotional problems were identified as independent predictors of malnutrition through multivariate analysis.

Health-related quality of life (HRQoL) was also notably impacted in CLD patients, particularly in physical functioning, emotional well-being, and perceived energy levels. Although some domains like social functioning and pain were less affected, malnutrition was associated with significant limitations in both physical and emotional aspects of daily life.

These findings emphasize the need for disease-specific screening tools like the RFH-NPT in accurately identifying malnutrition risk in CLD patients. Standard measures may overlook malnutrition in this population, especially when fluid retention distorts anthropometric values. Incorporating RFH-NPT into routine clinical assessments, alongside evaluation of dietary intake and emotional health among CLD patients, may enable earlier nutritional intervention, especially among those with ascites or low-calorie intake in preventing malnutrition risk among them. Lastly, future research should adopt longitudinal or interventional designs to better establish causal relationships and to explore the underlying mechanisms observed in this study. Larger, multicentre studies are also recommended to validate these findings across more diverse populations.

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Availability of Data: Please contact the correspondence author to obtain access to the data. However, it may be subjected to certain data only.

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