

Original Article



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Conflict of Interest

The authors have no financial conflicts of interest.

Utility of Subjective Global Nutritional Assessment Tool for the Assessment of Malnutrition in Pediatric Patients with Chronic Liver Disease

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ABSTRACT

Purpose: Approximately 30% of children with chronic liver disease (CLD) are malnourished. However, proper assessment of their nutritional status is difficult. The subjective global nutritional assessment (SGNA) is a comprehensive approach that uses nutrition-focused history and examination, followed by grading of malnourishment. We aimed to study the prevalence of malnutrition in children with CLD using the SGNA tool.

Methods: This cross-sectional observational study included patients aged <18 years with CLD. Nutritional assessments were recorded using SGNA tool. Conventional anthropometric measurements were performed and corroborated with nutritional status using SGNA tool.

Results: A total of 85 children with CLD and mean age of 62 months were enrolled in this study. The prevalence of malnourished children according to SGNA was 34%; 22% were moderately malnourished and 12% were severely malnourished. We found statistically significant differences in anthropometric parameters among the three groups. A moderate degree of agreement was found between SGNA and weight-for-age (W/A) ($p=0.020$), mid-upper arm circumference (MUAC) ($p<0.001$), and triceps skin-fold thickness (TSF)-for-age ($p=0.029$). Furthermore, a fair degree of agreement was found between height-for-age (H/A) ($p=0.001$) and weight-for-height (W/H) ($p<0.001$). The sensitivity of W/A for detecting malnutrition was 93%, H/A was 90%, MUAC was 86%, and TSF was 88%. The sensitivity was much lower for W/H and body mass index for age (55% for both).

Conclusion: In our study, more than one-third of children with CLD were malnourished. Nutritional assessment using SGNA is a reliable method for evaluating nutritional status and is significantly correlated with common anthropometric measurements.

Keywords: Subjective global nutritional assessment; Malnutrition; Anthropometry; Chronic liver disease; Nutritional assessment

INTRODUCTION

Hepatobiliary diseases are common causes of morbidity and mortality in children [1,2]. The cumulative effects of the underlying disease process leading to chronic liver disease (CLD) (including effects on appetite, dietary absorption, and assimilation), and the reduced synthetic functions of the liver causing hypoalbuminemia and increased risk of infections

have a negative impact on nutrition and growth [3,4]. Thus, malnutrition is a common complication in pediatric patients with CLD. Studies have shown that the prevalence of malnutrition in patients with CLD is >30% across different settings [5,6].

Nutritional status assessment is challenging in CLD, as anthropometric parameters such as weight-for-age (W/A) and body mass index (BMI) are not very reliable due to organomegaly and ascites. No consensus exists on the best method for classifying and quantifying malnutrition, but anthropometry is the most commonly used tool for nutritional assessments. A comprehensive nutritional assessment helps in understanding the severity of malnutrition and enables objective patient follow-up after nutritional counseling and dietary recommendations [7].

The subjective global nutritional assessment (SGNA) is a comprehensive approach for assessing nutrition in patients. The application of the SGNA in pediatric patients was initially described by Secker and Jeejeebhoy [2], and included a nutrition-focused medical history and physical examination with assignment of an overall SGNA score providing a severity grade for malnourishment [2,8]. The SGNA helps in assessment of patients who are at risk of developing malnutrition and related complications that are not identified by other objective methods [2,8]. Considering the previously discussed limitations of conventional anthropometric measurements in patients with CLD, we aimed to study the effectiveness of the SGNA in these patients.

MATERIALS AND METHODS

Patients

This prospective observational study aimed to evaluate the nutritional status of patients with CLD using the SGNA tool. The study cohort included patients diagnosed with CLD based on standard diagnostic criteria using a combination of radiological results, biochemical data, and liver histopathology. Patients with other chronic diseases such as celiac disease, human immunodeficiency virus, or malignancies, and those who received blood products or albumin in the preceding month were excluded. The etiology of CLD is divided into parenchymal and biliary types. Child-Turcotte-Pugh (CTP) scoring was performed for all patients at enrollment [9].

Study assessment

Baseline demographic data were collected for all patients. Baseline laboratory parameters, including complete blood count, serum electrolytes, serum coagulogram, liver function test, and vitamin B12 and D levels, were collected.

All patients underwent anthropometric measurements such as weight, height, mid upper-arm circumference (MUAC), and triceps skin-fold thickness (TSF), which are detailed in the **Supplementary Fig. 1**. The SGNA tool was subsequently used to document nutritional status, and patients were ultimately graded into three groups: A, well-nourished; B, moderately malnourished; and C, severely malnourished. Details of the parameters used in the SGNA tool are provided in the **Supplementary Fig. 1**.

All patients with malnutrition were provided with proper nutritional counseling and managed according to our institutional guidelines based on the severity of malnutrition. All

patients diagnosed with vitamin B12 and/or D deficiency during the study received adequate supplementation.

Statistical analyses

The primary objective of this study was to analyze the prevalence of malnutrition in this patient population. Secondary objectives included stratification of the malnutrition grade using the SGNA tool, correlation of the malnutrition grade to conventional anthropometric measurement tools, and association of the different etiologies of CLD in the study population with the grade of malnutrition assigned by the SGNA.

The collected data were transformed into variables, coded, and entered into Microsoft Excel Version 16.71 (Microsoft Co., USA). Next, the data were analyzed and statistically evaluated using the IBM SPSS Statistics ver. 28.0 software (IBM Co., USA). Quantitative data were expressed in means±standard deviations or medians with interquartile ranges, and the differences between two comparable groups were calculated using the student's *t*-test (unpaired) or the Mann Whitney U-test. Qualitative data were expressed in percentages, the chi square test or Fisher's exact test calculated statistical differences between the proportions, and the Spearman's correlation coefficient was used to determine correlations. A *p*-value<0.05 was considered statistically significant.

This study was approved by the Institutional Ethics Committee (LHMC/IEC/2020/PG Thesis/106) of the Lady Hardinge Medical College. Informed consent was obtained from the parents of all patients and assent was given, wherever applicable, in accordance with the Declaration of Helsinki.

RESULTS

From January 2021 to August 2022, 90 patients were screened. A total of 85 patients fulfilled the inclusion criteria and were included in the study for protocol-defined nutritional assessment. Fifty-five patients (64.7%) were male, and 54 of the 85 patients (63.5%) were newly diagnosed with CLD at the time of enrollment. The median age of the study population was 38 months (interquartile range, 6–113 months), 51 patients (59.9%) were below 5 years of age, and the remainder (39.9%) were above 5 years of age.

Etiopathology of CLD

Forty patients (47.1%) had parenchymal pathology for CLD, 23 patients (27.1%) had biliary pathology, 19 patients (22.3%) underwent further evaluation, and the remaining 3 patients had cryptogenic causes. The most common etiology of parenchymal liver disease was autoimmune hepatitis (AIH), seen in 14 patients (16.5%), whereas extrahepatic biliary atresia was the most common biliary cause of CLD, present in 12 patients (14.1%). Overall, 31 patients (36.5%) had CTP grade A, 46 (54.1%) had CTP grade B, and eight (9.4%) had CTP grade C.

Nutritional assessment based on the SGNA

According to the SGNA tool, 56 patients (65.8%) were well nourished (Group A), 19 patients (22.3%) were moderately malnourished (Group B), and 10 patients (11.9%) were severely malnourished (Group C). The highest frequency of severely malnourished patients (Group C) was observed in the infantile age group (7.1%). More patients with malnourishment (Groups B and C) were males (21 of 55 [38.2%]) than females (8 of 30 [26.7%]), but the difference

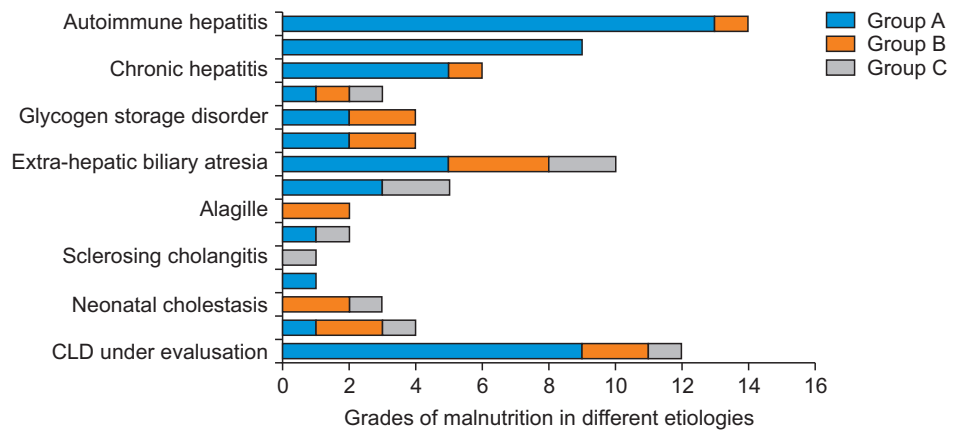


Fig. 1. Nutritional status of study subjects determined by SGNA among different etiologies of CLD. SGNA: subjective global nutritional assessment, CLD: chronic liver disease.

was not statistically significant ($p=0.34$). **Fig. 1** shows the distribution of SGNA malnutrition grades based on the etiology of CLD.

We next compared the severity of CLD based on the CTP scores with the SGNA malnutrition grades. Among the 31 patients with CTP grade A CLD, 6 patients (19.4%) had malnutrition based on the SGNA (Group B+Group C), 19 of 46 patients (41.3%) had CTP grade B, and 4 of 8 patients (50.0%) had CTP grade C CLD. Overall, among patients with severe malnourishment (SGNA Group C), only 2 of 10 patients (20.0%) had severe-grade CLD, whereas among well-nourished patients (SGNA Group A), 4 of 56 patients (7.1%) had severe-grade CLD ($p=0.24$). The CLD severity grade based on CTP was not significantly associated with the malnutrition severity grade determined by the SGNA tool.

SGNA and conventional anthropometric measurements

Of the 85 included patients, 44 were underweight and 25 (29.4%) were severely underweight. Twenty-six patients (30.6%) exhibited stunting, and 24 (28.8%) exhibited severe stunting. TSF thickness was <3rd percentile in 43 patients (50.6%), and MUAC-for-age indicated malnutrition in 23 patients (27.1%). Fifty-five patients (64.7%) had a normal BMI, 4 patients (4.7%) showed thinness, 1 showed severe thinness, and 1 was overweight. No patients were obese. **Fig. 2** shows a comparison of anthropometric measurements in patients aged <5 and ≥ 5 years.

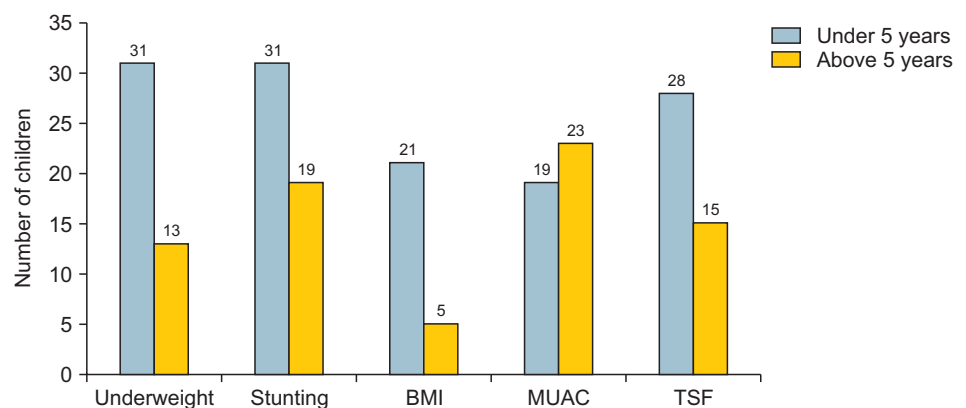


Fig. 2. Comparison of anthropometric parameters between children above and below 5 years of age. BMI: body mass index, MUAC: mid upper-arm circumference, TSF: triceps skin-fold thickness.

Table 1. Comparisons of nutritional status determined by SGNA and anthropometric z-scores in the study population

Anthropo-metric z-scores	Group A (n=56)	Group B (n=19)	Group C (n=10)	p-value	Post-hoc Tukey p-value		
					Between A and B	Between A and C	Between B and C
Weight-for-age	-1.5 (1.1)	-3.1 (1.3)	-4.3 (1.2)	<0.001	<0.001	<0.001	0.008
Height-for-age	-1.6 (1.4)	-3.3 (1.7)	-3.9 (1.0)	<0.001	0.002	<0.001	0.546
Weight-for-height	-0.8 (1.6)	-1.4 (1.7)	-2.6 (0.8)	0.025	0.655	0.017	0.131
BMI-for-age	-0.9 (1.4)	-1.6 (1.5)	-3.3 (1.7)	<0.001	0.341	<0.001	0.001
MUAC-for-age	-1.6 (1.5)	-3.0 (0.9)	-4.6 (1.9)	<0.001	0.077	<0.001	0.033
TSF-for-age	-1.4 (1.5)	-2.7 (1.3)	-3.8 (1.4)	0.004	0.095	<0.001	0.189

Values are presented as mean (standard deviation).

SGNA: subjective global nutritional assessment, BMI: body mass index, MUAC: mid upper-arm circumference, TSF: triceps skin-fold thickness.

Table 2. Performance of SGNA in detection of malnutrition compared to various anthropometric parameters

Detection of malnutrition by anthropometric z-scores	Group B and C determined by SGNA			
	Sensitivity (%)	Specificity (%)	Positive predictive value	Negative predictive value
Weight-for-age	93.1	69.4	61.3	95.1
Height-for-age	89.6	57.1	52.0	91.4
Weight-for-height	54.5	82.7	70.5	70.5
BMI-for-age	55.1	82.1	61.5	77.9
MUAC-for-age	85.7	46	40	88.4
TSF-for-age	88.0	59.6	51.1	91.1

SGNA: subjective global nutritional assessment, BMI: body mass index, MUAC: mid upper-arm circumference, TSF: triceps skin-fold thickness.

We compared the malnutrition grades based on the SGNA with the anthropometric z-scores. Significant differences were found between the three groups using ANOVA with Tukey's post-hoc *p*-test (**Table 1**). Group A had higher absolute values of anthropometric indices than Groups B and C. Statistical differences were identified between Groups A and B in W/A ($p<0.001$) and height-for-weight (H/A) ($p=0.002$). Significant differences were found between Groups A and C in relation to all anthropometric parameters. Furthermore, significant differences were found between Groups B and C in W/A ($p=0.008$), BMI ($p=0.001$), and MUAC ($p=0.033$) (all $p<0.05$). The kappa coefficient showed the highest agreement between W/A and malnutrition (Groups B and C) based on the SGNA (kappa=0.55), and the lowest agreement with weight-for-height (W/H) (kappa=0.38). Our study showed the maximum sensitivity of malnutrition based on the SGNA with W/A (93.1%), followed by H/A (89.6%), TSF-for-age (88%), and MUAC-for-age (85.7%) (**Table 2**).

Laboratory parameters and the SGNA

Table 3 provides a detailed breakdown of the laboratory parameters of the study patients stratified by SGNA groups. Based on the age-specific hemoglobin cutoff, anemia was present in 52 children (61.2%). Low serum-albumin levels (56 patients, 65.9%) were found to be higher in Group C. The vitamin D level was deficient in 26 patients (30.6%), insufficient in 12 patients (14.2%), and significantly lower in patients with severe malnutrition (Group C) when compared to that in Groups A and B. Patients with malnutrition had significantly higher total and direct bilirubin levels than those in Group A.

DISCUSSION

In this study, the assessment of nutritional status using the SGNA showed that 29 (34.1%) patients had malnutrition, of whom 10 (11.9%) had severe malnutrition. A comparative assessment of the SGNA and anthropometric measurements showed that W/A showed the highest degree of agreement and sensitivity. Notably, based on the SGNA, the sensitivity

Table 3. Comparisons of mean hematological and biochemical parameters with malnutrition grade determined by SGNA in the study population

Biochemical parameters	Malnutrition grade			p-value
	Group A (n=56)	Group B (n=19)	Group C (n=10)	
Hemoglobin (g/dL)	10.3 (2.0)	10.0 (1.7)	9.5 (1.9)	0.421
WBC (10 ⁹ /L)	10.0 (5.2)	12.1 (6.3)	14.0 (8.8)	0.083
Platelets (10 ⁹ /L)	260 (160)	300 (150)	260 (90)	0.551
Total bilirubin (mg/dL)	4.2 (6.3)	8.5 (9.3)	8.6 (6.1)	0.030
Direct bilirubin (mg/dL)	2.3 (3.9)	5.1 (5.7)	5.0 (5.9)	0.032
Total protein (g/dL)	6.5 (0.8)	6.2 (0.9)	6.5 (0.8)	0.558
Serum albumin (g/dL)	3.2 (0.7)	3.1 (0.5)	3.1 (0.3)	0.970
SGOT (IU/L)	230.9 (371.8)	262.2 (263.1)	196.9 (147.1)	0.875
SGPT (IU/L)	172.2 (203.6)	223.8 (292.4)	128.6 (94.1)	0.491
INR	1.3 (0.5)	1.2 (0.4)	1.3 (0.5)	0.903
Vitamin D (ng/mL)	27.3 (16.0)	20.4 (16.2)	11.3 (5.2)	0.007
Vitamin B12 (pg/mL)	464.1 (204.7)	579.3 (310.7)	588.6 (537.3)	0.197
Folic acid (nmol/L)	17.9 (9.9)	20.3 (11.0)	18.8 (11.9)	0.697

Values are presented as mean (standard deviation).

SGNA: subjective global nutritional assessment, WBC: white blood cell, SGOT: serum glutamate oxaloacetate transaminase, SGPT: serum glutamate pyruvate transaminase, INR: international normalized ratio.

of MUAC and TSF thickness was favorable when compared to that of malnutrition (Groups B+C), indicating that the SGNA is a suitable screening tool for identifying pediatric CLD patients with malnutrition.

Most patients had parenchymal involvement (n=40, 47.1%), followed by those with biliary pathology (n=23, 27.1%). Among the parenchymal cases, most were identified as AIH followed by cases with Wilson's disease (16.5% and 7.5%, respectively), and among the cases with biliary pathology, the majority (n=12, 14.1%) had extrahepatic biliary atresia. These etiologies were also common in studies by Bharti et al. [6], in which 24% of cases had Wilson's disease, 18% had AIH, and 26% were undergoing workup. In a study by Pawaria et al. [1] most cases had biliary atresia, followed by progressive familial intrahepatic cholestasis, AIH, and Wilson's disease.

We found that 34.2% of the study participants exhibited malnutrition, as assessed by the SGNA method, concurring with other studies showing a higher than 30% prevalence of malnutrition in children with CLD. A study by Pawaria et al. [1] showed that based on the SGNA, 41.3% of children were malnourished, 29.3% were moderately malnourished, and 12% were severely malnourished. In a previous study by El Koofy et al. [10], 52.2% of children were underweight, and malnutrition was directly correlated with the severity of hepatic dysfunction, particularly in CTP class C cases.

Significant differences were found in all anthropometric parameters between Groups A and C ($p < 0.05$), which is consistent with the study by Pawaria et al. [1] ($p < 0.05$). Moreover, significant differences were found between Groups B and C with respect to weight ($p = 0.008$), BMI ($p = 0.001$), and MUAC ($p = 0.033$). Furthermore, the differences between Groups A and C were more significant than those between Groups A and B, indicating that the SGNA is more reliable for classifying children with severe malnourishment.

The classification of nutritional status by SGNA was also in significant agreement with classification by anthropometric parameters ($p < 0.05$) for all indices, with the exception of BMI-for-age ($p = 0.622$). These results are comparable with those from other studies, such as Sudhakar and Dhaarani Giri [11]. The degree of agreement was moderate for W/A, MUAC-

for-age, and TSF-for-age ($p=0.020$, $p=0.005$, and $p<0.001$, respectively), and fair for the remainder of the indices. This finding differs from the results of a study by Pawaria et al. [1], where strong agreement with W/A and moderate agreement with stunting was found, whereas the remaining indices, including MUAC and TSF, showed a fair degree of agreement.

In our study, the SGNA showed a sensitivity of 93.1% with W/A. This outcome could be attributed to the greater number of children with fewer complications, such as ascites or organomegaly, enrolled from the outpatient clinic. Our study also showed that the sensitivities of MUAC (85.7%) and TSF-for-age (88%) were higher than those of W/H and BMI-for-age (54.5% and 55.1%, respectively). These findings are in contrast to those in a study by Pawaria et al. [1], who showed a sensitivity of 77.8% and 78.8% for MUAC and TSF, respectively. In that study, they also showed a sensitivity of 84.5% for W/H, and 82.8% for BMI-for-age. Our results indicate that MUAC and TSF are sensitive tools for screening malnutrition and can identify more cases than wasting and BMI, especially in children with complications of CLD, such as ascites or organomegaly. This finding was also observed in a study by Silva et al. [12], where the nutritional status indicated by TSF and MUAC was better than that indicated by weight. Schenider et al. [13] found that the best index for identifying children at nutritional risk was TSF thickness. The results of our study are comparable to those of Mahdavi et al. [14] in children admitted to various departments, showing fair to moderate agreement between the SGNA and anthropometric parameters, including weight, height, TSF, and MUAC ($k=0.34$, $p<0.001$).

In the present study, significant differences were found among the three malnutrition groups classified by the SGNA with respect to three laboratory parameters: total bilirubin ($p=0.030$), direct bilirubin ($p=0.032$), and Vitamin D levels ($p=0.007$). In children belonging to Groups B and C, the total and direct bilirubin levels were higher than those in Group A. In addition to the reduced absorption of lipid-soluble vitamins in cholestatic diseases, the prevalence of nutritional vitamin D deficiency in the community could be an additional factor contributing to the higher prevalence of vitamin D deficiency in our study. Low albumin levels are a marker of CLD severity, although they may also indicate malnutrition. These are interconnected pathologies and discerning their exact causes is often challenging.

This study was limited by the number of patients enrolled, the absence of stratified sampling based on the severity and etiology of CLD, and the inclusion of patients enrolled from an inpatient versus outpatient setting. Also, given the cross-sectional nature of the study, the impact of nutritional counselling on patients with malnutrition could not be studied. In addition to children with CLD, the application of the SGNA as a tool for detecting malnutrition has been evaluated in other patients, such as those with cerebral palsy, critically ill patients, and postoperative patients. The SGNA focuses on the nutritional history of the child and thus identifies children at risk of developing malnutrition, and not those otherwise identified by an objective method. Prospective studies with a larger number of patients and longitudinal follow-up are required to better understand the effect of detecting malnutrition using the SGNA tool, and application of therapeutic interventions guided by it. Based on current evidence, the SGNA can be used with anthropometric measurements as a complementary tool for assessing malnutrition.

In summary, our single-center cross-sectional observational study showed that the SGNA detected malnutrition in 34.2% of pediatric patients with various etiologies of CLD, and demonstrated reasonable agreement with conventional methods of malnutrition assessment

through standalone anthropometric measurements. Larger studies with prospective follow-ups of patients are warranted to determine the effects of nutritional counseling on malnourished patients. Therefore, the SGNA should be more commonly used to assess malnutrition in children with CLD.

SUPPLEMENTARY MATERIAL

Supplementary Fig. 1

Pediatric subjective global nutritional assessment proforma

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